

AD-A073 168

NEW YORK STATE DEPT OF ENVIRONMENTAL CONSERVATION ALBANY F/G 13/2
NATIONAL DAM SAFETY PROGRAM. BOG BROOK DAM NUMBER 1 (NY-00068) --ETC(U)
SEP 78 J J WILLIAMS

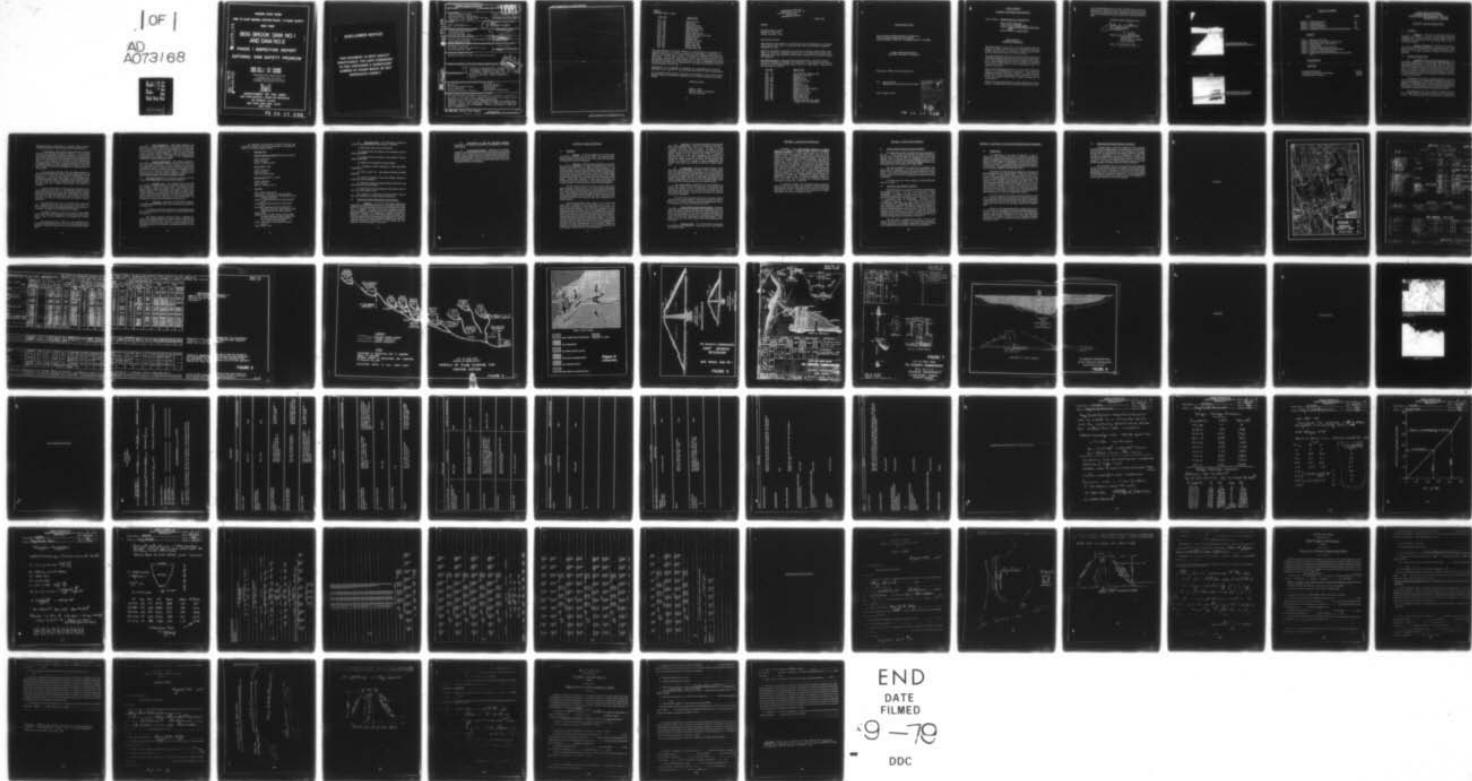
DACW51-78-C-0035

NL

UNCLASSIFIED

| OF |
AD
A073168

FILE
NAME



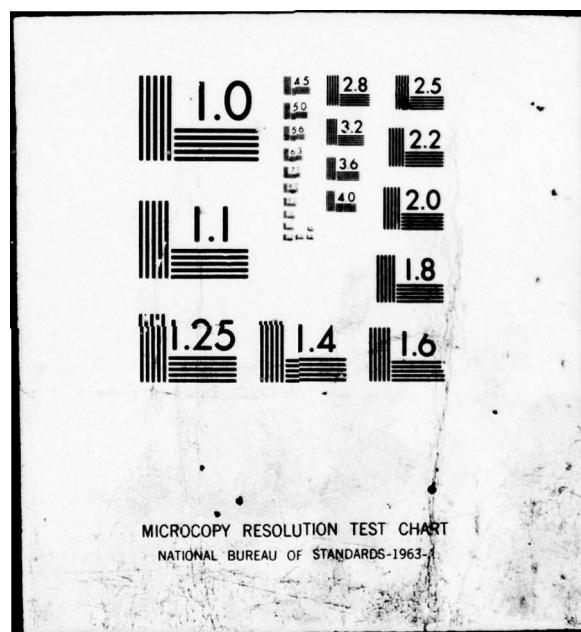
END

DATE

FILMED

9-78

DDC



SC
HUDSON RIVER BASIN

TRIB. TO EAST BRANCH CROTON RIVER, PUTNAM COUNTY

DA073168

NEW YORK

BOG BROOK DAM NO. 1 AND DAM NO. 2

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

DAM NO. 1 - NY 00068
DAM NO. 2 - NY 00069

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED
CONTRACT NO. DACW 51-78-C-0035



DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10007
JULY 1978

DDC FILE COPY

79 08 27 030

DISCLAIMER NOTICE

**THIS DOCUMENT IS BEST QUALITY
PRACTICABLE. THE COPY FURNISHED
TO DDC CONTAINED A SIGNIFICANT
NUMBER OF PAGES WHICH DO NOT
REPRODUCE LEGIBLY.**

REPORT DOCUMENTATION PAGE			READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT CATALOG NUMBER	LEVEL A
4. TITLE (and Subtitle) Phase I Inspection Report Bog Brook Dam No. 1 and Dam No. 2 Hudson River Basin, Putnam County, New York Inventory No. N.Y. 68 & 69		5. TYPE OF REPORT & PERIOD COVERED Phase I Inspection Report National Dam Safety Program	
7. AUTHOR(s) <u>John J. Williams</u> P.E. <u>10</u>		6. PERFORMING ORG. REPORT NUMBER <u>15</u> DACW 51-78-C-0035	
9. PERFORMING ORGANIZATION NAME AND ADDRESS O'Brien and Gere Engineers/ 1301 Buckley Road Syracuse, New York 13221		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS <u>12 75P.</u>	
11. CONTROLLING OFFICE NAME AND ADDRESS New York State Department of Environmental Conservation/ 50 Wolf Road Albany, New York 12233		12. REPORT DATE 18 Sep 1978	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Department of the Army 26 Federal Plaza/ New York District, CofE New York, New York 10007		15. SECURITY CLASS. (of this report) UNCLASSIFIED	
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; Distribution unlimited.		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE	
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) <u>6</u>		23 AUG 1979 DRAFTED C FILLED C RECORDED	
18. SUPPLEMENTARY NOTES National Dam Safety Program. Bog Brook Dam Number 1 (NY-00068) and Dam Number 2 (NY-00069), Hudson River Basin, Tributary to East Branch Croton River, Putnam County, New York. Phase I Inspection Report.			
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dam Safety Bog Brook Dam No. 1 National Dam Safety Program Bog Brook Dam No. 2 Visual Inspection Putnam County Hydrology, Structural Stability East Branch of Croton River			
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization. Bog Brook Dam No. 1 and No. 2 were inspected and judged to be unsafe, non-emergency. Dam No. 1 has significant seepage at junction of the north abutment and downstream face of embankment. Dam No. 2 has growth of trees and brush on embankment.			

393 970

JCB

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

BRUNSWICK COUNTY PUBLIC SCHOOLS | BRUNSWICK COUNTY, NC

Digitized by srujanika@gmail.com

J. G. LAMBERT AND MOL

NANEN-P

Honorable Hugh L. Carey

<u>I.D. NO.</u>	<u>NAME OF DAM</u>
N.Y. 49	Pocantico Dam
N.Y. 445	Attica Dam
N.Y. 658	Cork Center Dam
N.Y. 153	Jackson Creek Dam
N.Y. 172	Lake Algonquin Dam
N.Y. 318	Sixth Lake Dam
N.Y. 13	Butlet Storage Dam
N.Y. 90	Putnam Lake (Bog Brook Dam)
N.Y. 166	Pecks Lake Dam
N.Y. 674	Bradford Dam
N.Y. 75	Sturgeon Pool Dam
N.Y. 414	Skaneateles Dam
N.Y. 155	Indian Lake Dam
N.Y. 472	Newton Falls Dam
N.Y. 362	Buckhorn Lake Dam

The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

Consequently, it is advisable to implement the recommendations previously furnished in the reports for the above-mentioned dams as soon as practicable.

It is requested that owners of these dams be furnished a copy of this letter and that copies be permanently appended to all reports previously furnished to you.

Sincerely yours,

CLARK H. BENN
Colonel, Corps of Engineers
District Engineer

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, NEW YORK
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10007

2 OCT 1978

NANEN-F

Honorable Hugh L. Carey
Governor of New York
Albany, New York 12224

Dear Governor Carey:

The purpose of this letter is to inform you of a clarification of the guidelines used by this office in assessing dams under the National Program of Inspection of Dams.

Office of the Chief of Engineers has recently provided a clarification that dams with seriously inadequate spillways are to be assessed as unsafe, non-emergency, until more detailed studies prove otherwise or corrective measures are completed.

The following dams in your state have previously been assessed as having seriously inadequate spillways, with capability to pass safely only the percentage of the probable maximum flood as noted in each report. They are now to be assessed as unsafe:

<u>I.D. NO.</u>	<u>NAME OF DAM</u>
N.Y. 59	Lower Warwick Reservoir Dam
N.Y. 4	Salisbury Mills Dam
N.Y. 45	Amawalk Dam
N.Y. 418	Jamesville Dam
N.Y. 685	Colliersville Dam
N.Y. 6	Delta Dam
N.Y. 421	Oneida City Dam
N.Y. 39	Croton Falls Dam
N.Y. 509	Chadwick Dam (Plattenkill)
N.Y. 66	Boyd's Corner Dam
N.Y. 397	Cranberry Lake Dam
N.Y. 708	Seneca Falls Dam
N.Y. 332	Lake Sebago Dam
N.Y. 338	Indian Brook Dam
N.Y. 33	Lower(S) Wicopee Dam (Lower Hudson W.S. for Peekskill)

HUDSON RIVER BASIN

Name of Dams: Bog Brook Dam No. 1 and Dam No. 2

County and State: Putnam County, New York

Inventory Numbers: Dam No. 1 - NY 00068; Dam No. 2 - NY 00069

PHASE I INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM

Prepared by: O'Brien and Gere Engineers, Inc.

For: New York State
Department of Environmental Conservation

Date: August 17, 1978

Accession For	
NTIS GRA&I <input checked="" type="checkbox"/>	
DDC TAB <input type="checkbox"/>	
Unannounced <input type="checkbox"/>	
Justification _____	
By _____	
Distribution/ _____	
Availability Codes _____	
Dist	Avail and/or special
A	23

79 08 27 030

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dams: Bog Brook Dam No.1 and Dam No.2

State Located: New York

County Located: Putnam County

Stream: Tributary to East Branch of the Croton River

Date of Inspection: July 17, 1978

ASSESSMENT OF
GENERAL CONDITIONS

Bog Brook Dams No. 1 and No. 2 are earth embankments with masonry corewalls. Neither structure is provided with a spillway; however, the reservoir is connected by a tunnel to East Branch Reservoir which is provided with a 500 foot spillway.

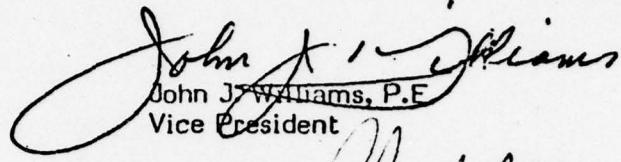
Two major depressions were observed along the crest of Dam No. 1; significant seepage and saturated ground were noted at the junction of the north abutment and the downstream slope of the embankment. These conditions should be further investigated to determine the source or cause, and how these conditions may affect the stability of Dam No. 1.

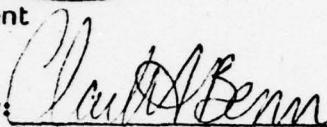
The trees and brush growing on Dam No. 2 may have a deleterious affect on the compacted earth embankment. Trees, brush and vegetation growing on Dam No. 2 should be cut near the ground surface and a further investigation made to determine the extent of the root systems before further remedial measures can be recommended.

Results of the hydrologic/hydraulic analysis indicate that the dams could be overtopped by all floods exceeding approximately 83 per

cent of the Probable Maximum Flood. The East Branch spillway is hydraulically inadequate to pass flood flows associated with the PMF; however, the spillway is not considered "seriously inadequate" as cited in Engineering Technical Letter No. 1110-2-234, May 10, 1978.

O'BRIEN & GERE ENGINEERS, INC.

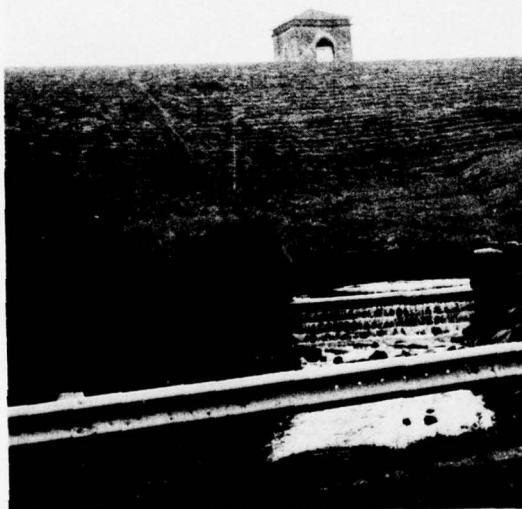

John J. Williams, P.E.
Vice President

Approved by: 
Clark H. Benn
Colonel, Corps of Engineers
District Engineer

Date: 18 September 78



UPSTREAM SLOPE AND
CENTER GATEHOUSE DAM NO. 1



DOWNSTREAM SLOPE AND
STILLING BASIN DAM NO. 1

TABLE OF CONTENTS

TEXT

PAGE

Section 1 - Project Information	1-6
Section 2 - Visual Inspection	7-8
Section 3 - Hydrologic/Hydraulic	9
Section 4 - Structural Stability	10
Section 5 - Assessment, Recommendations/Remedial Measures	11-12

FIGURES

Figure 1 - Regional Vicinity Map	
Figure 2 - Data Table - New York City Reservoirs	
Figure 3 - Flow Diagram for Croton System	
Figure 4 - Geologic Map	
Figure 5 - Transverse Embankment Sections	
Figure 6 - Dam No. 1 Plan and Section of Gatehouse	
Figure 7 - Connecting Tunnel and Gatehouse	
Figure 8 - Section of Outlet Works and Elevation Drawing Dam No. 1	

PHOTOGRAPHS

APPENDIX

Field Inspection Report	A1-A8
Hydrologic and Hydraulic Computations	A9-A19
Previous Inspection Reports	A20-A33

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAMS BOG BROOK NO. 1 ID# 00068
BOG BROOK NO. 2 ID# 00069

SECTION I - PROJECT INFORMATION

1.1 GENERAL

a. Authority - This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with contract #1467.021 between O'Brien and Gere Engineers, Inc. and the New York State Department of Environmental Conservation.

b. Purpose of Inspection - The purpose of this inspection is to evaluate the structural and hydraulic conditions of Bog Brook Dam No. 1 and Dam No. 2 and appurtenant structures, and to determine if the dams constitute a hazard to human life or property.

1.2 PROJECT DESCRIPTION

a. Description of Dams and Appurtenances (From information supplied by the City of New York, Department of Environmental Protection) The Bog Brook dams are located in southeastern Putnam County about $1\frac{1}{2}$ miles east of Brewster, New York. The impoundment area was formed by the construction of Dam No. 1, across a tributary to the East Branch of the Croton River, and Dam No. 2, which was constructed across a depression on the dividing line between the watershed of Bog Brook and that of another small stream.

According to the section drawings supplied by the New York City Department of Environmental Protection, both dams are rolled earth embankments with masonry corewalls extending into bedrock. The upstream slope of both structures is protected by stone riprap. Each embankment is provided with a downstream toe drainage ditch consisting of a trench backfilled with cobbles.

Bog Brook Dam No. 1 has a maximum height of about 47 feet, is approximately 1,340 feet long and has a top width of about 25 feet. The upstream slope is $2\frac{1}{2}$ horizontal to 1 vertical; the

downstream slope is 2 horizontal to 1 vertical. Refer to Figure 5 for details concerning transverse sections of this embankment.

A rectangular, stone masonry outlet structure is situated near the crest and near the center of Dam No. 1. Flow into the structure is accomplished through four openings: one at the toe of the upstream slope, one at mid-height and two at operating pool level. The two lower inlets are controlled by sluice gates (each 3 feet by 5 feet) housed in the structure and are provided with stoplogs upstream of the gates. The upper two inlets are controlled by stoplogs placed in a slot immediately downstream of the sluice gates. Refer to Figure 6 of the appendix for a detailed section of this structure.

Two thirty-inch diameter cast iron pipes, housed in a horseshoe-shaped brick-lined culvert, convey the discharge through Dam No. 1. About 30 feet beyond the downstream toe of embankment, the conduits pass through a vault containing two horizontal stem gate valves. The pipes continue downstream about 200 feet where the discharge from each pipe exits through a fountain orifice into a common stilling basin. (See Figure 8 of Appendix).

A second stone masonry outlet structure is situated on the south abutment of Dam No. 1. This structure houses two gate valves and a butterfly valve which control discharge into a 10 foot diameter, brick-lined connecting tunnel. (See Figure 7 for details). The tunnel is 2,200 feet long and is used to maintain the same operating pool level in Bog Brook and East Branch (Sodom) Reservoirs.

Bog Brook Dam No. 2 has a maximum height of about 23 feet, is approximately 1,936 feet long and has a top width of 12 feet. Both the upstream and downstream slopes are 2 horizontal to 1 vertical. See Figure 5 for transverse section details.

Bog Brook Reservoir is part of the Croton Water Supply System; the Dams and Appurtenant Structures are owned by the City of New York and operated by the Department of Water Supply.

Bog Brook Dams No. 1 and No. 2 were designed by the Aqueduct Commissioners, City of New York and were constructed by David R. Paige & Company between February 1889 and August 1893.

b. Size Classification - Big Brook Reservoir was designed for a storage volume of 4.4 billion gallons (13,500 acre-feet) at the maximum operating pool elevation of 417 feet mean sea level (MSL). The maximum heights of Dam No. 1 and Dam No. 2 are 47 feet and 23 feet respectively. Since the normal storage volume is between 1,000 and 50,000 acre-feet, the dams are in the intermediate size category as defined by the Recommended Guidelines for Safety Inspection of Dams.

c. Hazard Classification - The Village of Brewster, New York is located within 1½ miles of Dam No. 1 and Dam No. 2. The topography downstream of both structures is such that overtopping or failure of either structure would direct flood waters towards the Village of Brewster resulting in the possible loss of many lives and extensive property damage. Therefore, both structures are in the high hazard category as defined by the Recommended Guidelines for Safety Inspection of Dams.

1.3 PERTINENT DATA (From information supplied by the City of New York, Department of Environmental Protection)

a) Drainage Area - The drainage area of the Bog Brook Reservoir is about 3.73 square miles and the surface area of the reservoir is about 0.64 square miles. Bog Brook and East Branch (Sodom) Reservoirs together form what is known as the "Double Reservoir 1". While these two basins have about equal storage capacities, the watershed of East Branch is about twenty times as large as Bog Brook Reservoir. Therefore, to equalize the supply received by each reservoir, the two impoundments are connected by a tunnel which is described in Section 1.2.a.

b. Discharges - Discharge from Bog Brook Reservoir is accomplished through operation of two sluice gates as described in Section 1.2.a.

A statutory conservation discharge of 5 million gallons per day must be maintained to the tributary to the East Branch of the Croton River.

East Branch (Sodom) Reservoir, which is operated in tandem with Bog Brook Reservoir, is provided with a 500 foot long spillway at Elevation 416.55 feet MSL. Since no spillway was constructed at the Bog Brook site, the discharge capacity of the East Branch spillway was apparently considered adequate for both reservoirs.

The maximum pool elevation of 419.15 feet MSL was recorded on October 16, 1955 and corresponds to a discharge of 6,240 cfs over the East Branch spillway.

c. Reservoir Data

Maximum Operating Pool (Reservoir at El. 416.55)

Length - 8,700 feet
Area - 399 acres
Volume - 13,500 acre-feet

Top of Dam (El. 425)

Length - 9,500 feet
Area - 405 acres
Volume 17,130 acre-feet

Maximum Pool (PMF - El. 425.5)

Length - 9,600 feet
Area - 408 acres
Volume - 17,460 acre-feet

d. Dam Data

Type - earth embankments
Top Elevation ~ 425 feet (Dam No.1 and No.2)
Original Ground Elevations - 378 feet (Dam No.1)
402 feet (Dam No.2)
Lengths - 1,340 feet (Dam No.1); 1,936 feet (Dam No.2)
Top Widths - 25 feet (Dam No.1); 12 feet (Dam No.2)
Side Slopes - upstream slope $2\frac{1}{2}:1$ (Dam No.1)
upstream slope 2:1 (Dam No.1); down-
stream slope 2:1 (Dam No.1 and No.2)
Zoning - none
Impervious Core - rubble masonry: 10 feet wide
at base narrowing to 4 feet at crest (Dam No. 1); 4 feet wide at base narrowing
to 2.5 feet at crest (Dam No.2)
Cutoff - base width of core extends into sound
bedrock
Grout Curtain - none

e. Engineering Data - The information available for review of Bog Brook Dam No. 1 and Dam No. 2 included:

- 1) Data Table - New York City Reservoirs
- 2) Excerpts from the "Report to the Aqueduct Commissioners, 1887-1895"
- 3) Excerpts from the "Report to the Aqueduct Commissioners, 1895-1907"
- 4) Profile of Flow Diagram for Croton System
- 5) Transverse Section Drawings of both Bog Brook Embankments
- 6) Plan of Dam No. 1 and Section Drawing of Outlet Gatehouse
- 7) Plan of Connecting Tunnel and Section Drawing of Connecting Tunnel Gatehouse
- 8) Elevation Drawing of Upstream Slope of Dam No.1 and Section Drawing of Outlet Works
- 9) Dam Report by the Conservation Commission, State of New York, dated August 6, 1915
- 10) "Report of a Structure Impounding Water", State of New York, Department of State Engineer and Surveyor

1.4 OPERATING AND MAINTENANCE PROCEDURES

a. Operation - Two 30 inch drain pipes, operable for drawdown and low flow augmentation, are controlled by gate valves located in the outlet gatehouse and valve vault downstream of Dam No. 1. In addition, two gate valves and an emergency butterfly valve for control of discharge through the connecting tunnel to East Branch Reservoir are available for drawdown of Bog Brook Reservoir. According to Mr. John Birrell, Section Engineer, New York City Department of Environmental Protection, the valves are exercised every six months; and adjusted periodically to maintain a minimum conservation discharge of 5 million gallons per day. Reservoir elevation readings are taken daily.

b. Maintenance of Dam and Operating Facilities
According to Mr. Birrell, maintenance is performed on a "most needed" basis.

c. Flood Warning System - According to Mr. Birrell, inspection crews are placed on round the clock duty during periods of high runoff. Reservoir levels are checked hourly, and high pool levels or unusual observations are reported to Mr. Birrell and the Deputy Chief Engineer. Mr. Birrell would contact local police and the Civil Defense for evacuation of downstream areas in the event of impending failure or overtopping.

SECTION 2 - VISUAL INSPECTION

2.1 FINDINGS

a. General - The field inspection of the Bog Brook embankments took place on July 17, 1978. The reservoir water surface elevation was about 415 feet MSL during the inspection. No underwater areas were inspected.

b. Dam No. 1 - The riprap on the upstream face of the dam is a poorly graded mix of large, flat boulders (1 to 5 feet in diameter) and small rocks (6 inches or less in diameter). The boulders appear to have been individually selected and placed to maximize contact between adjacent stones while the cobbles were used as filler for the remaining voids. There is no visible vertical or horizontal displacement of the boulders but some of the cobble backfill near the water line has apparently been removed by wave action. Brush piles composed of small trees and bushes are scattered across the upstream face. This vegetation had apparently been cut down to root level shortly before the field inspection.

The dam crest, as well as the uppermost four feet of the upstream slope, is grass covered. Two long, shallow depressions were noted in the embankment crest: one immediately in front of the center gatehouse and another approximately 150 feet to the north. Each depression grades parallel to the long axis of the dam and reaches a maximum depth of about 18 inches. According to the operating personnel, these features have been noticeable for a period of years.

The entire downstream face of Dam No. 1 is covered with grass which is reported to be mowed about twice a year. No indications of settlement or slope misalignment were noted on the slope during the inspection. The toe drain extending from the southeast abutment to the center of the embankment is partially obscured by grass and brush growing amongst the cobble backfill. Some ponded water was noted in the drain during the inspection. Seepage was observed where the downstream slope of the embankment intersects the north slope of the stream valley. The ground surface, for about 20 yards to either side of the intersection and extending from the valley crest to the toe of the embankment is generally very moist and saturated in a few locations. Wheel ruts about 12 to 15 inches deep have been cut into the embankment and valley slopes in this area by the mowing equipment.

c. Dam No. 2 - The riprap protection on the upstream face of this embankment is similar to the riprap on Dam No. 1. The entire upstream slope and crest of the dam is heavily overgrown with small trees and brush. In addition to this vegetation, the downstream slope supports trees as tall as 50 feet. (Visual inspection of this structure was limited to walking a footpath along the dam crest, inspecting the upstream and downstream slopes at randomly selected locations and walking through the woods parallel to and below the downstream toe). Although no evidence of seepage or slope misalignments was evident, observations were severely limited due to dense vegetation.

d. Outlet Works - All of the original equipment inside the center outlet gatehouse, including the floor gratings, pulley hoists and supporting steel beams appear to be in fair condition. The sluice gate controlling the lowest inlet was completely opened at the time of inspection while the other gate was inoperable and scheduled for repairs. Both of the downstream stoplog slots were closed; spillage (about 30 gpm) into the southern outlet conduit was evident due to improper seating of the individual planks.

The tunnel gatehouse situated on the south abutment of Dam #1 also appears to be in fair condition. The butterfly valve located just upstream of the two sluice gates is inoperable, and according to the operator, the valve stem is rusted out with the valve in the open position. The two gate valves were not operated at the time of inspection.

The valve vault and tunnel housing for the outlet conduits appears to be in good condition. There was no evidence of flow in the tunnel at the time of inspection but some standing water (about 6 inches deep) was noted on the floor of the vault.

e. Stilling Basin and Downstream Channel - Extensive underwater plant growth was observed in the stilling pond and vines were seen growing between the rocks which form the walls of the basin. The cross-section of the stone lined channel downstream of the stilling basin appears uniform but is overgrown with weeds and brush. Flow from the stilling basin is conveyed through a 7 foot diameter culvert under a road located about 100 yards downstream of the dam.

f. Reservoir Area - The natural ground surrounding the reservoir has a moderate to steep slope and is well covered with trees and brush.

SECTION 3 - HYDROLOGY/HYDRAULICS

According to the Recommended Guidelines for Safety Inspection of Dams, the Spillway Design Flood is the Probable Maximum Flood (PMF). The PMF was calculated from the 12 hour Probable Maximum Precipitation (PMP), using a loss rate of 0.1 inches per hour. The flood hydrograph was constructed from the Snyder unit hydrograph using average coefficients. Flood routing through the "Double Reservoir 1" was performed assuming the gated outlets to be closed, and the crest of the East Branch spillway to be at 425 feet MSL. The peak inflow and outflow rates were calculated as 58,000 cfs and 55,500 cfs respectively. The peak outflow corresponds to a stage of 9 feet above the spillway crest (0.5 feet above the top of dam). Peak inflow and outflow rates for one-half of the PMF were calculated as 29,000 cfs and 25,500 cfs respectively. The spillway capacity was calculated to be approximately 43,000 cfs. Although the spillway capacity is insufficient to pass the PMF, it will safely discharge at least one-half of the PMF, and is therefore not considered seriously inadequate, as cited in ETL 1110-2-234.

A drawdown analysis was performed assuming discharge from the two 36 inch pipes, the connecting tunnel closed, the starting water surface at the spillway crest, and 2 cfs per square mile inflow (7.5 cfs). According to the calculations, complete drawdown of the reservoir would take 30 days.

SECTION 4 - STRUCTURAL STABILITY

4.1 VISUAL OBSERVATIONS AND DATA REVIEW

Two observations were made during the visual inspection of Dam No. 1 which suggest the existence of unstable conditions: The two long, narrow depressions in the dam crest indicate the possible loss of material from the embankment due to fines migration, and the saturated ground and seepage observed at the north abutment indicate that uncontrolled seepage path(s) have developed through the embankment or valley slopes.

The entire embankment of Dam No. 2 is overgrown with trees, brush and vegetation. The roots of the large trees on the slopes may be providing seepage paths which could lead to future piping. These trees could also be uprooted by high winds, which would result in the removal of a large volume of material from the embankment.

No design data was made available for either Bog Brook Dam No. 1 or No. 2.

4.2 GEOLOGY AND SEISMIC STABILITY

Bog Brook Reservoir is located in the New England Uplands physiographic province. The rocks in this province are either metamorphic or igneous, and the land forms show a close relationship to the relative durability of these rocks. Both of the Bog Brook embankments are founded upon metamorphic Precambrian hornblende gneiss and amphibolite. According to the discussion on Dam No. 1 in the "Report to the Aqueduct Commissioners, 1887-1895", the upper zone of this bedrock, was said, "excavated to a considerable depth to avoid the percolation of water through its fissures." The apparent weathered condition of this rock necessitated excavations as deep as 50 feet below the original ground surface in an effort to encounter competent material on which to found the masonry corewall. Figure 8 of the Appendix shows a plot of the bottom of the corewall, the top of the rock and the groundline along the center of Dam No. 1.

No fault zones or lineaments are known to exist in the vicinity of the dams or reservoir. The structures are located in Seismic Risk Zone 1 of the Seismic Zone Map of Contiguous States and it appears that static stability conditions are satisfactory.

SECTION 5 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

5.1 ASSESSMENT

The depressions in the crest of Dam No. 1 may be indicative of fines migration through the embankment although no evidence of seepage or misalignments was noted on the downstream slopes immediately below the depressions. Surface erosion does not appear to be the cause of the depressions since the ground surface is uniform and there is no standing water or excessive moisture at the low points. The operating personnel stated that these features have remained unchanged for at least eight years.

According to Mr. Birrell, Section Engineer, the seepage and saturated ground at the north abutment of Dam No. 1 has existed for a number of years except during extended periods of dry weather. Fine-grained soil is not in evidence either in the seepage or as accumulated deposits on the dam and valley slopes. The "Report to the Aqueduct Commissioners, 1895-1907" states, sic "notwithstanding that precaution (extending the corewall into what was considered competent bedrock), a slight infiltration occurs, which has been collected in a system of drains and led finally through small pipes, where its volume can be constantly observed." The location of these pipes is unknown and it is possible that the observed seepage is a result of a clogged drain system.

The root systems of the trees and brush growing on Dam No. 2 may have a deleterious affect upon the compacted materials in the embankment and provide seepage paths which could lead to future piping and failure of the structure. In addition, high winds could uproot the trees and remove large portions of the embankment.

Results of the hydrologic/hydraulic analysis indicate that the dams could be overtopped by all floods exceeding approximately 83 per cent of the Probable Maximum Flood. The East Branch spillway is hydraulically inadequate to pass flood flows associated with the PMF; however, the spillway is not considered "seriously inadequate" as cited in Engineering Technical Letter No. 1110-2-234, May 10, 1978.

5.2 RECOMMENDATIONS/REMEDIAL MEASURES

A boring program should be initiated at several sections (including the depressed areas) of the embankment to include, but not be limited to, determination of the composition and in-situ properties of the embankment and foundation materials to establish if they are satisfactory for the embankment, corewall and foundation as designed and constructed; to assist in the determination of the cause of the seepage and to detect possible fines migration. The results of these investigations should be used to perform seepage and stability analyses for the embankment.

The inoperable valves in the connecting tunnel gatehouse and the outlet gatehouse should be repaired. The trees and brush growing on Dam No. 2 should be cut near the ground surface and an investigation made to determine the extent of the root systems before additional measures are undertaken. The toe drainage ditch for both structures should be cleared of debris and vegetation to insure proper collection of runoff and seepage.

FIGURES

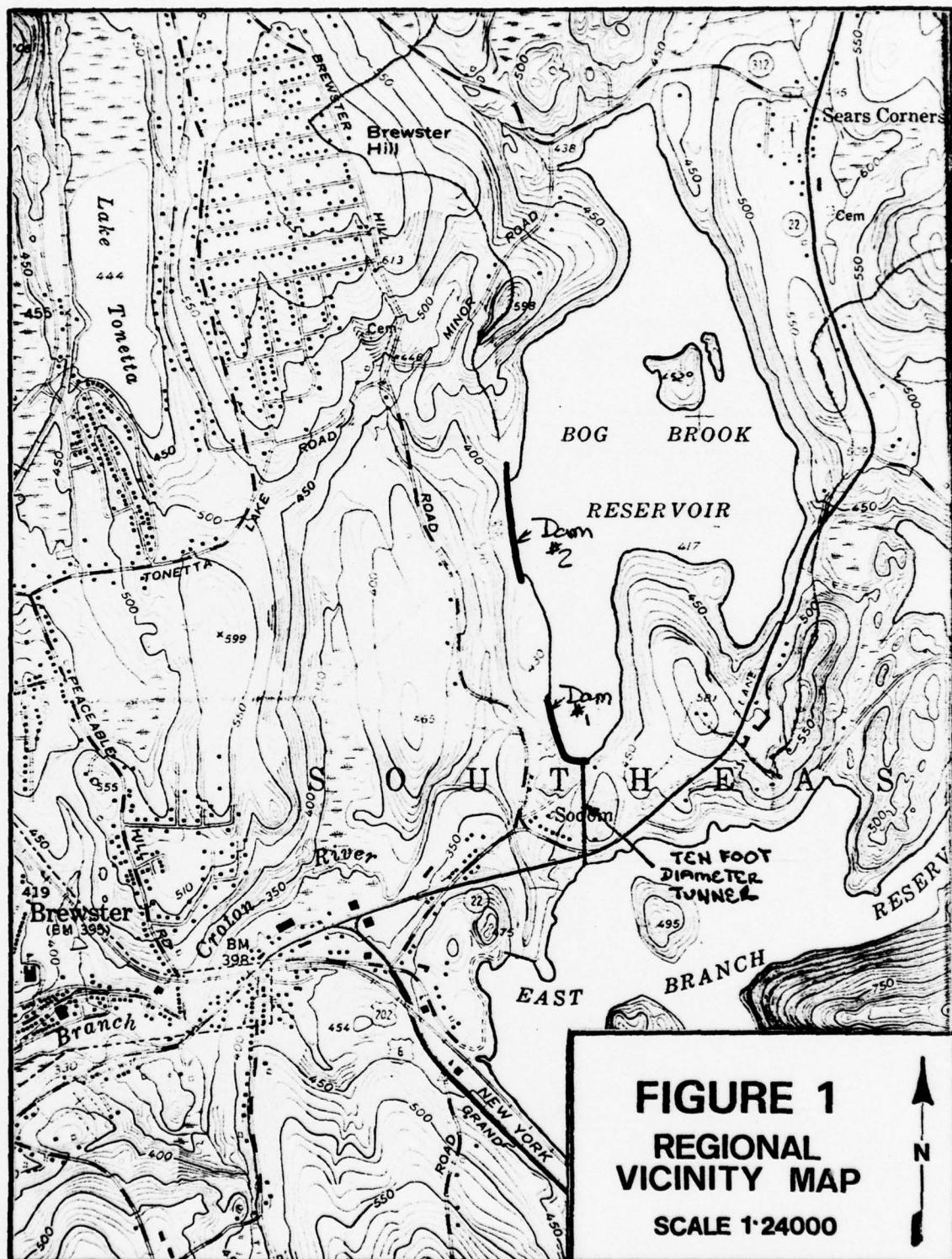


FIGURE 1
REGIONAL VICINITY MAP

SCALE 1:24000

CROTON SYSTEM

DATA P

Name of Reservoir	Location		Drainage Area		Date Pl.	King
	Town	County	Sq Mi	Includes Items		
1 BOYDS CORNERS	KENT	PUTNAM	79.46	1	1073	MASONRY, EARTH, M
2 BARRETT'S POND			55	2	112	EARTH
3 LAKE GREENDALE	CARMEL	"	0.60	3	1070	EARTH
4 WEST BRANCH	CARMEL	"	97.87	1, 2, 4	1095	EARTH, MASONRY, CON
5 WEST BRANCH						
6 MIDDLE BRANCH	SOUTHEAST		21.51	5	1070	EARTH, MASONRY, CON
7 BOG BROOK	"		5.67	6	1092	"
8 EAST BRANCH (BOODAH)			80.20	6, 7	1091	MASONRY, EARTH, M
9 CROTON FALLS (DIVERGING)	"		67.56	6, 8, 9	1011	EARTH, CONCRETE, CO
10 LAKE GILEAD	CARMEL	"	0.82	9	1070	EARTH
11 CROTON FALLS	"		160.64	1, 5, 6, 9, 10	1011	CYCLOPEAN MASON
12 LAKE K R R	"		7.84	11	1070	EARTH
13 AMAWALK	SOMERS - WESTCHESTER	"	191.5	10, 11, 12	1097	EARTH, MASONRY, CO
14 TITICUS	NORTH SALEM	"	79.35	13	1093	MASONRY, EARTH, M
15 CROSS RIVER	BEDFORD	"	29.80	14	1006	CYCLOPEAN MASON
16 MUSCOOT	SOMERS & BEDFORD	"	515.75	10, 11, 13	905	MASONRY
17 NEW CROTON	CORTLAND	"	375.00	1, 10, 12	1093	MASONRY
18 Control 37 Lakes						
						CROTON TOTAL - 6

CATSKILL SYSTEM

1 ASHOKAN	OLIVE BRIDGE - ULSTER	1297.00	1	9.5	MASONRY
2 SCHOMARIE	3 L BOA - GREENE	134.00	2	19.6	MASONRY
	CATSKILL TOTALS				

DELAWARE SYSTEM

1 NEVERSINK	NEVERSINK	SULLIVAN	93.0	1	953	EARTH, CONCRETE
2 PEPACTON	COCHESER AND S	DELaware	372.0	2	954	"
3 CANNONSLILL	SHOOLETON	DELaware	4500	3	967	ROLLED
4 RONDOUT	DEPOS & TOWNSHIPS & WALTON	DELaware	75.00	4	1051	CONCRETE
	WARWICK AND NEVERSINK	ULSTER	10.00			
		SULLIVAN	10.0			
	DELAWARE TOTALS					

KENSICO RESERVOIR

KENSICO	MT. BUCKINGHAM - WESTCHESTER	13.33	19.5	11450.87
---------	------------------------------	-------	------	----------

PERTAINING TO N.Y. CITY RESERVOIRS

THE IMPOUNDING RESERVOIRS BELONG TO THE
OPERATING LEVEL & 560.0 MILL GAL. (AVAILABLE)

OF DAM	Capacity (B.L. Gal.) Total Area able Above Sill or Outlet Min. Op. Sill	Area of Water Surfaced & Spillway ELEV.	Length of Storage Miles	Elev. of Spillway M.S.L. Sandy Hook Feet	Elev. of F.M. of Max Depth Min. Open Level Feet	Elev. or Sill or Outlet Feet	Depth Spillway to Outlet Feet
				Sq. Mi.	Acres		
135	1.696	0.464	295.9	6.2	500.05	536.7	49.4
	0.170	0.100	67.1	.4	778.55	788.6	10.0
	0.163	0.264	160.9	2.2	504.35	477.6	5.0
122 & 52...N.Y.	10.970	1.692	1002.0	15.6	503.2	455.0	47.0
DRE	4.005	0.609	426.2	6.02	371.55	310.5	61.1
	4.400	0.620	399.0	4.9	416.55	363.1	51.5
49	5.243	0.690	556.0	10.5	416.55	351.0	65.0
CORE & SPILLWAY	0.888	0.240	153.6	4.2	309.55	275.0	39.0
	0.380	0.191	122.2	2.1	496.55	400.6	16.0
N.Y.	14.192	1.640	1062.4	18.0	309.4	214.6	95.0
	0.565	0.158	101.1	3.1	502.55	504.0	10.0
DRE	6.692	0.947	806.1	8.5	399.55	354.6	65.0
VADS W/ MASONRY CORE DAM, CONCRETE FACES	7.167	1.046	669.4	8.1	324.5	249.6	75.0
	10.308	1.202	764.2	12.9	329.55	224.6	105.0
	4.914	1.822	1166.1	35.0	190.55	169.6	30.0
	25.702	3.550	2259.2	38.0	195.55	194.6	36.0
	94.637	86.6	15.531	9911.0	177.52		

127.858	122.9	12.99	6315.2	40.2	UNKNOWN	UNKNOWN	300.00	52.73	1.
19.583	17.3	1.79	145.0	16.5	1130.0	-	1050.0	00.00	
147.441	140.5	14.73	9460.2	56.5					

CORE	35466	34.9	2.9	1470	16.5	1440.00	1319.00	1314.00	126.00	1.
.	143.701	140.2	0.9	5700	53.5	1230.00	1152.00	1143.00	137.00	6.
FILL	96726	95.7	7.5	4800	53.5	01150.00	01150.00	1040.00	035.00	0115.00
CORE	50048	49.6	3.25	2050	17.0	840.00	723.00	720.00	120.00	2.5
	325.941	320.4	21.95	4050	143.5	LOW WEIR HIGH "				

SAFETY OR INTERIM STORAGE PES FOR ALL OF THE CATSKILL & DELAWARE SUPPLIES

30573	14000	347	2210.3	300	357.00	UNKNOWN	295.52	61.63	
-------	-------	-----	--------	-----	--------	---------	--------	-------	--

CROTON, CATSKILL & DELAWARE SYSTEMS TOTALLING 547.5 B/L GAL. ABOVE MIN.
LE ABOVE SILL. AN ADDITIONAL 30.6 BILL. GAL. IS STORED IN A SAFETY STORAGE RES KENSICO

Dead Storage Villion gallons	Length of Spillway Feet	Max Depth 36.00 Spillway Feet	Max Hgt of Main Dam	Width of Dam Feet		Length of Dam Feet	
				Above Lowest Foundation Feet	Above Nort. Surface Feet	Top	Bottom.
150	700	57.0	60	59.60	6700	6700	
200	66.0	62.0	19.00	907.50	1704.5	260.0	
AC 52.00	65.0	50.0	28.00	240.00	741.0		
1000	99.0	50.00	680.00	613.0	1000.0		
0	88.8	23.8	22.88	173.38	1338.8		
5000	93.0	70.0	12.00	53.00	1100.0	500.0	
10000	51.0	45.0	15.00	240.00	2190.0	1000.0	
7000	173.0	119.0	29.00	110.00	1300.0	1100.0	
500		62.0	58.00	636.00	1270.0	50.0	
2000	135.0	107.0	25.70	75.21	1319.0	250.0	
2400	170.0	126.0	23.00	110.90	1060.0	670.0	
9500	56.0	4.00	40.00	1150.0	1152.0		
10000	277.0	174.0	10.00	206.00	2160.0	2160.0	

REMARKS

Most of the Croton carried by the New Aqueduct

0.137	950.0	72.73	252.0	210.0	26.33	200.00	4650.0	1000.0
	1324.0	150.0	102.0	155.0	15.00	150.00	2200.0	2000.0

Schoharie water is carried by Tunnel to Aqueduct to enter the Catskill Aqueduct

1.600	600.0	175.00	345.0	195.0	60.00	1392.00	2020.0	NONE
0.000	000.0	100.00	304.0	204.0	60.00	1460.00	2450.0	"
0.92	240.0	76.00	196.0	179.0	45.00	1312.00	2800.0	"
0.560.0	95.00	196.0	179.0	45.00	1312.00	2800.0	"	
307	600.0	175.00	375.0	195.0	60.00	1392.00	2400.0	"

Neversink, Pepacton and Delaware are conveyed via the N.Y. & W. Delaware Tunnel Thence all Four supplies converge at the Cannonsville Reservoir

130	50.0	155.50	307.0	163.0	23.00	235.00	1043.0	1043.0
-----	------	--------	-------	-------	-------	--------	--------	--------

of the Croton Supply plus pumpage from the Falls flows into the Cannonsville Reservoir

unmarked
map

Comp J.J.O
Drawn JRD.

Supply is
Croton

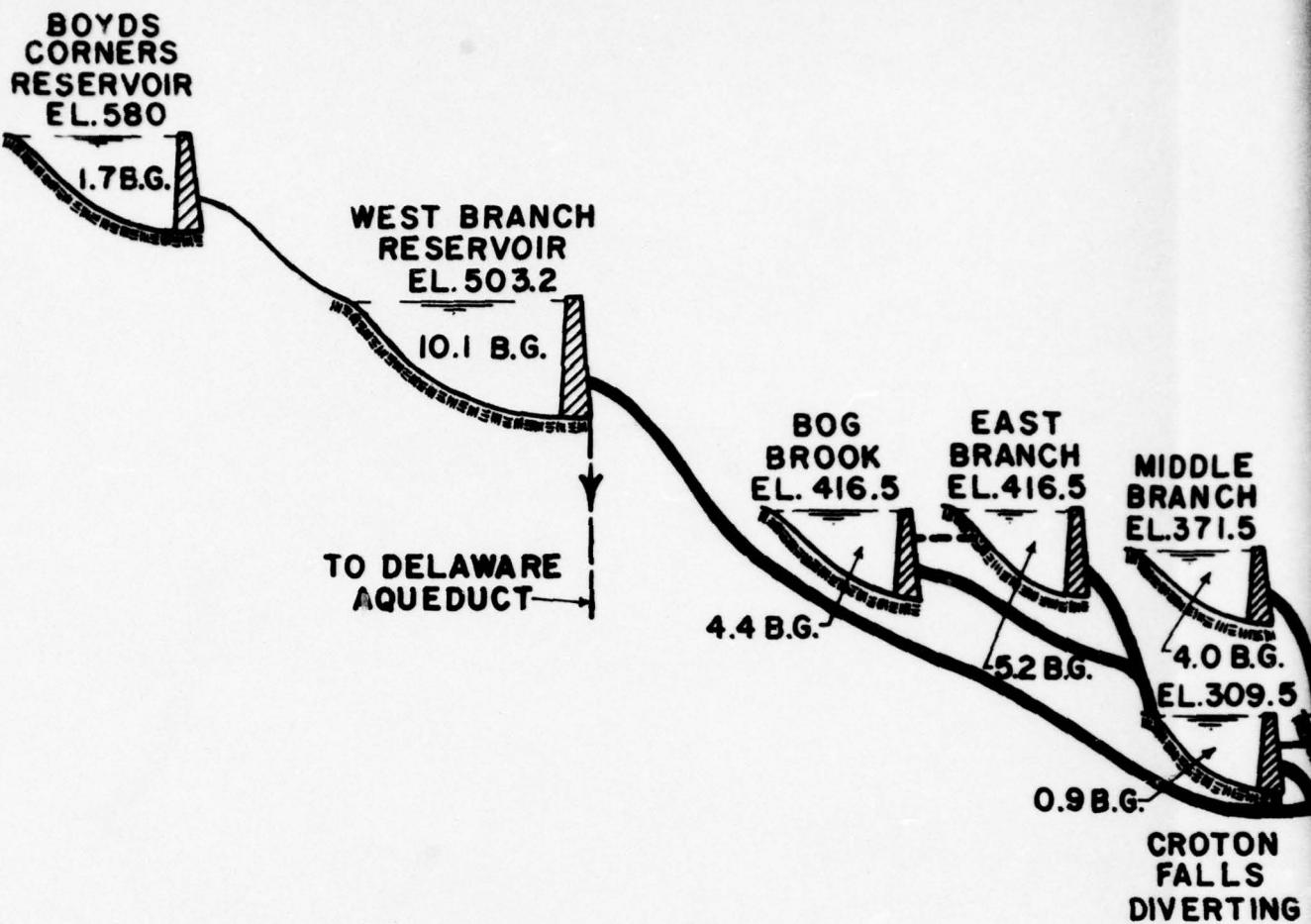
supplied by the Shandaken
s. Thence both supplies
enter aqueduct.

& Cannonsville supplies
Neversink, East Delaware
is to the Rondout Res.
plies enter the Del. Aqueduct.

FIGURE 2

all of the West Branch
Cross River & Croton
Reservoir.

Acc NS



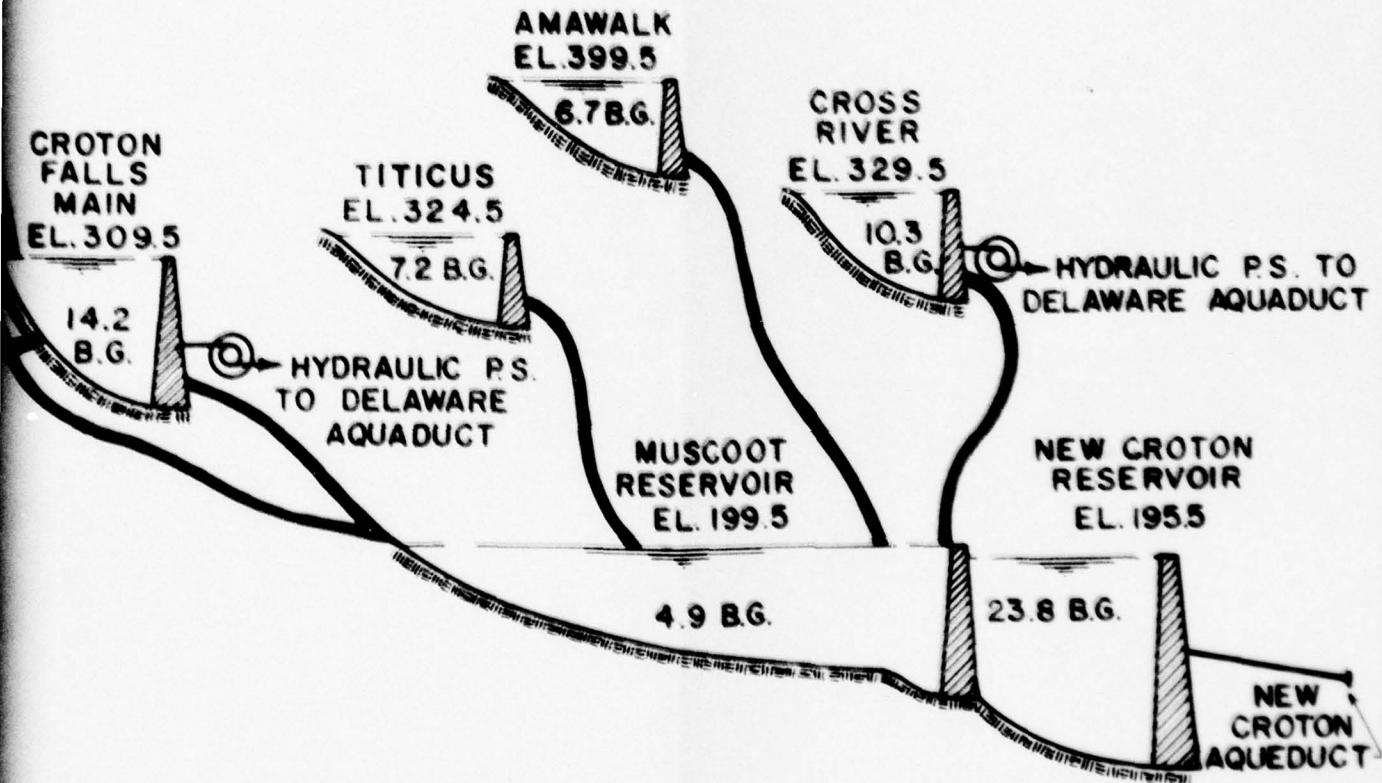
LEGEND

- = NATURAL WATER COURSE.
- - - = TUNNEL AQUEDUCT.
- = GRADE AQUEDUCT.

NOTE

ELEVATIONS OF RESERVOIRS ARE AT MASONRY
CREST OF SPILLWAY.
FIGURES SHOWN IN RESERVOIRS ARE CAPACITIES
IN BILLION GALLONS.

ELEVATIONS REFER TO M.S.L. SANDY HOOK.

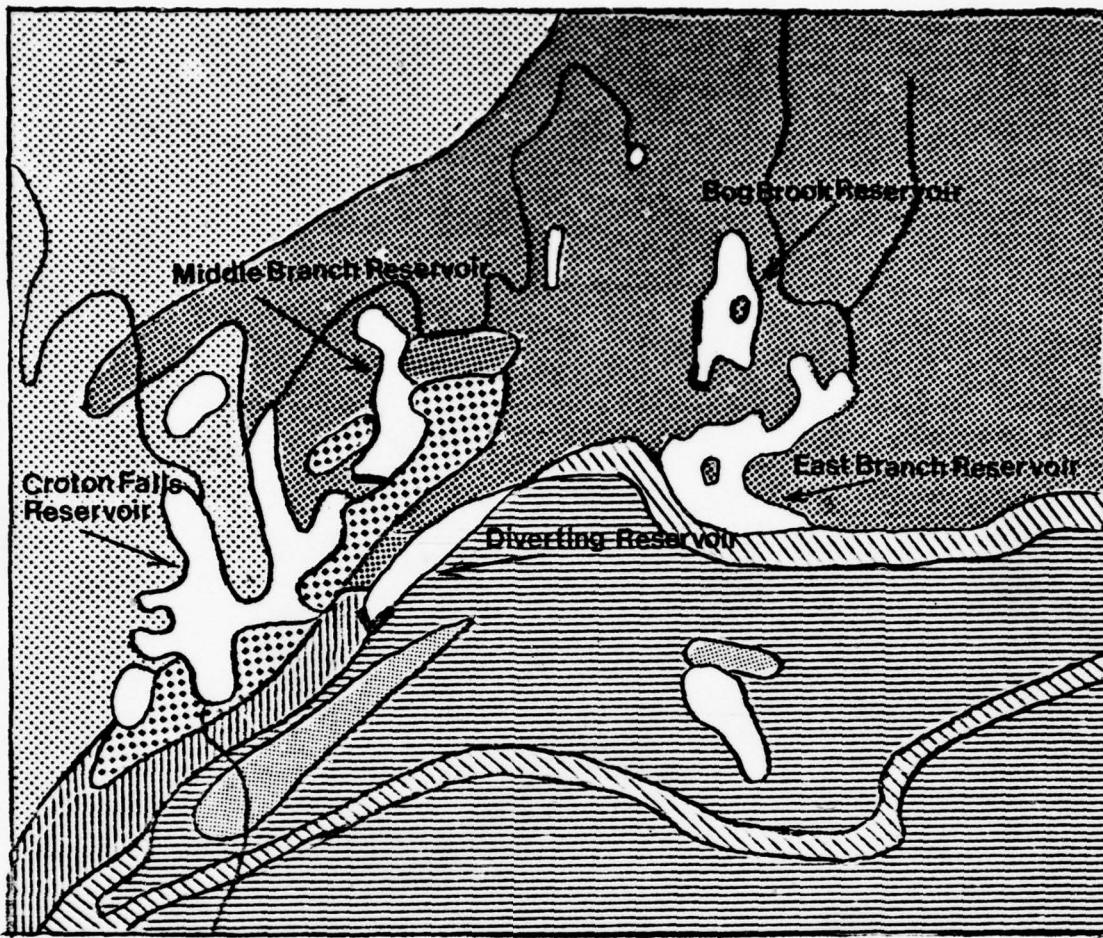


CITY OF NEW YORK
BUREAU OF WATER SUPPLY

PROFILE OF FLOW DIAGRAM FOR CROTON SYSTEM

FIGURE 3

2



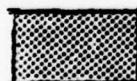
Scale: 1 inch = 1.7 miles



bqpc - biotite, quartz, plagioclase



Xi - marble



Am - Amphibolite



bg - biotite, granitic gneiss



qtcs - quartz, feldspar, gneiss

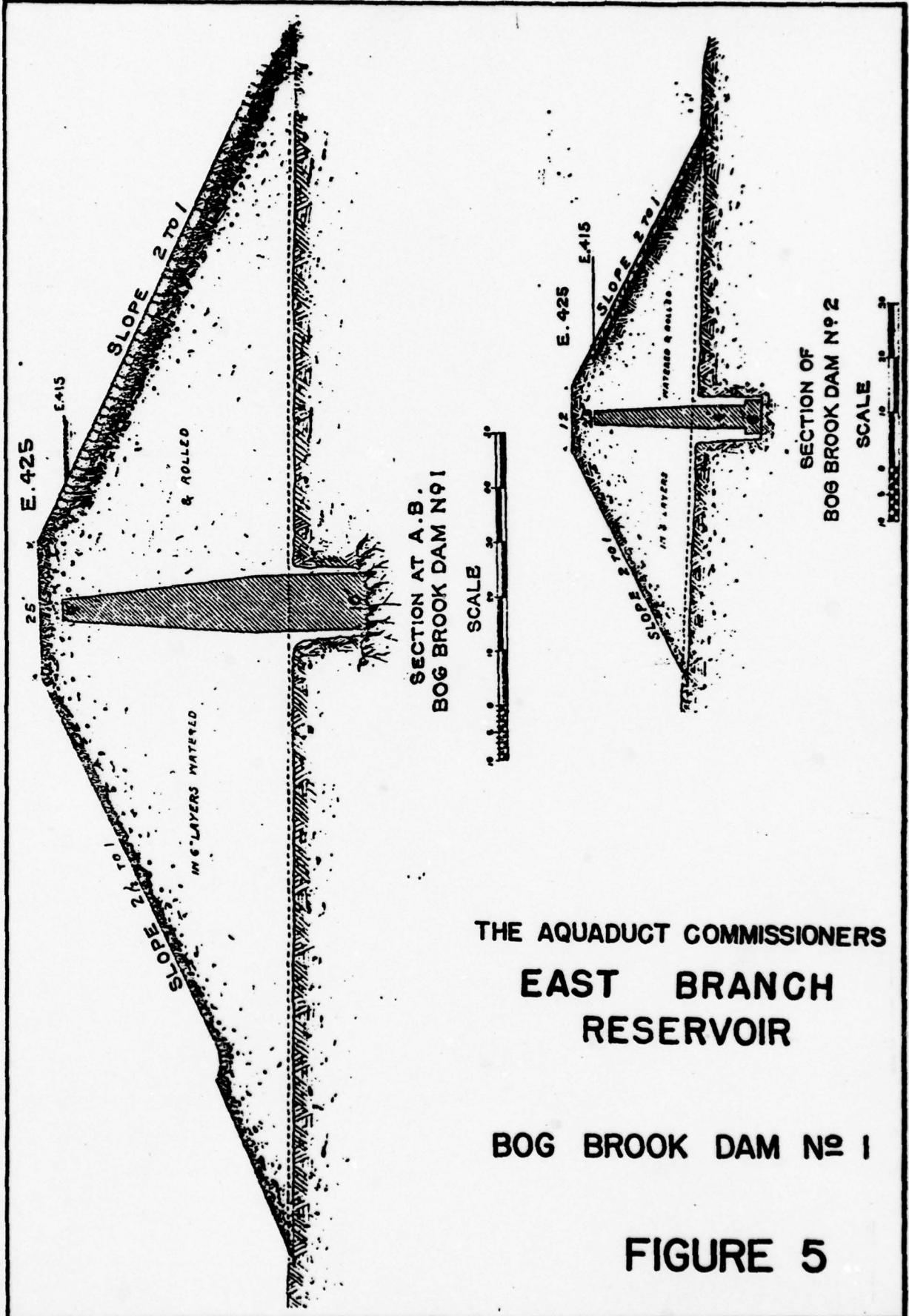


Xm - schistose gneiss

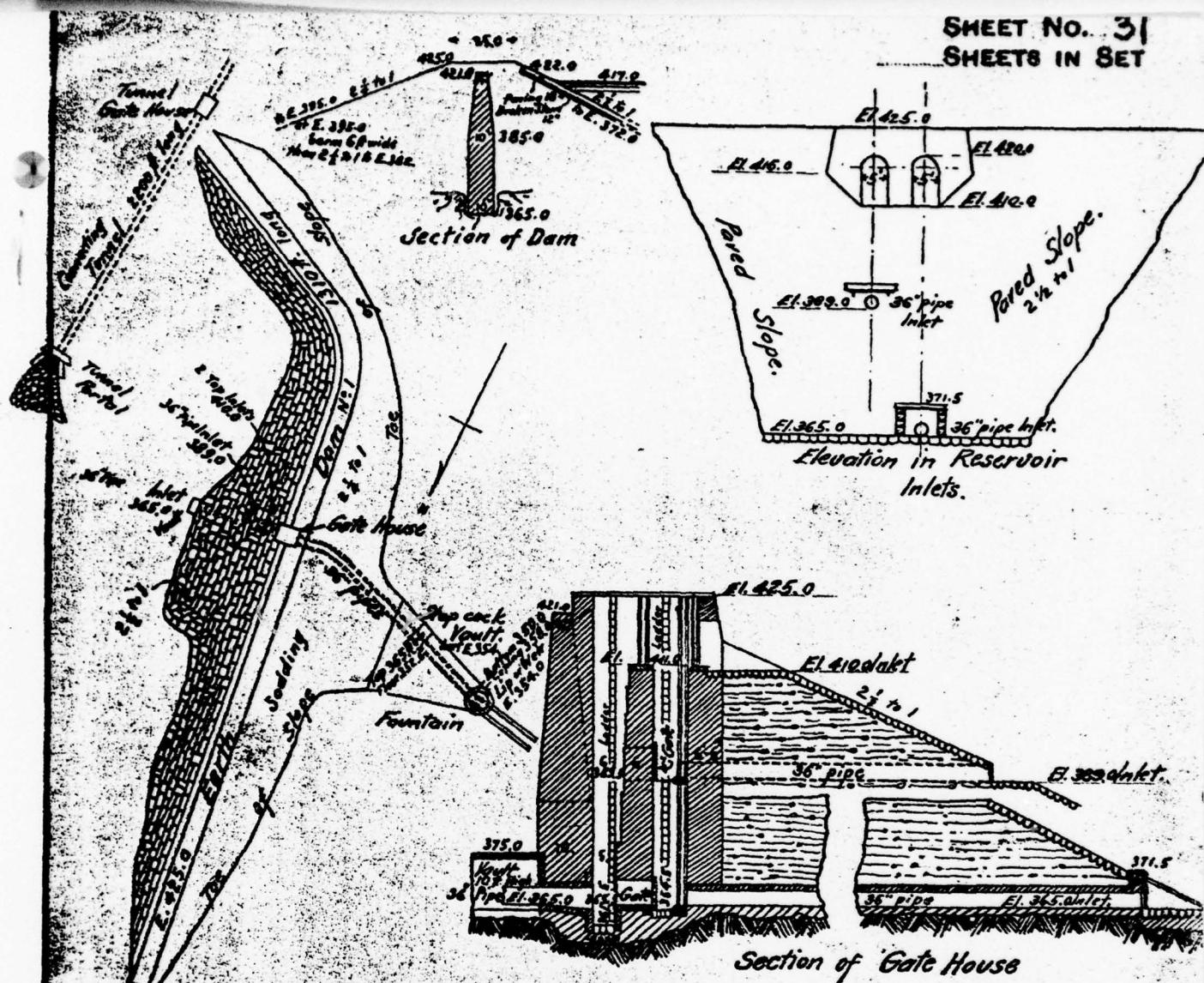


Xgb - gabbro, hornblende, gneiss

Figure 4
Geologic Map



SHEET NO. 31
SHEETS IN SET



Inlets		Outlets		Gates		Stop-cocks		Remarks -		
Number	Shape and Dimension	Number	Shape and Dimension	Elevation of Invert	Number	Size	Elevation of Invert	Number	Diam.	Elevation of Invert
2	T 1' 6" x 5'-3"	410.	2	354	1	2'x5'	3895	2	36"	354.
1	3'-1"	389	354	1	2'x5'	3655				No Spillway El. top of Fountain 354. Earth Dam N°2 is 1935 ft. long.

**CITY OF NEW YORK
THE AQUEDUCT COMMISSIONERS**

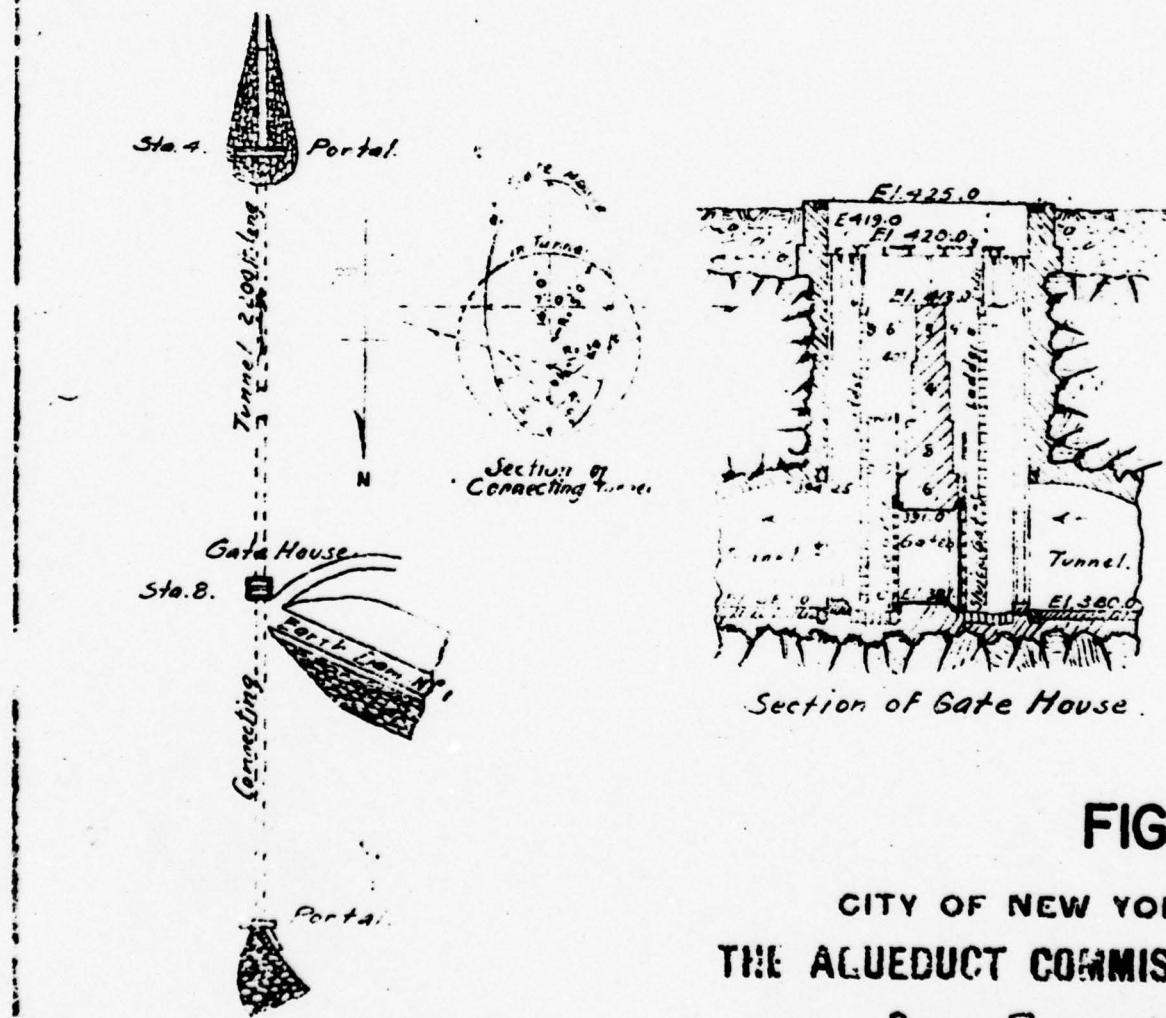
DOUBLE RESERVOIR™

BOG BROOK

~~Group A.S.F.~~
~~Formerly W.E.K.~~
~~Now W.E.K. & J.P.G.~~

FIGURE 6 EARTH DAM N° 1.
ACCESSION NO.

Name	Inlets.		Outlets		Gates	Stop cocks	Remarks.
	Shape and Dimension	Elevation of Invert	Number	Shape and Dimension	Elevation of Invert		
1. At Portal 10' dia.		380.	1.	Same as Inlets.	381 1/2		
1. At Gate House. 7' dia.		380.	1		380		

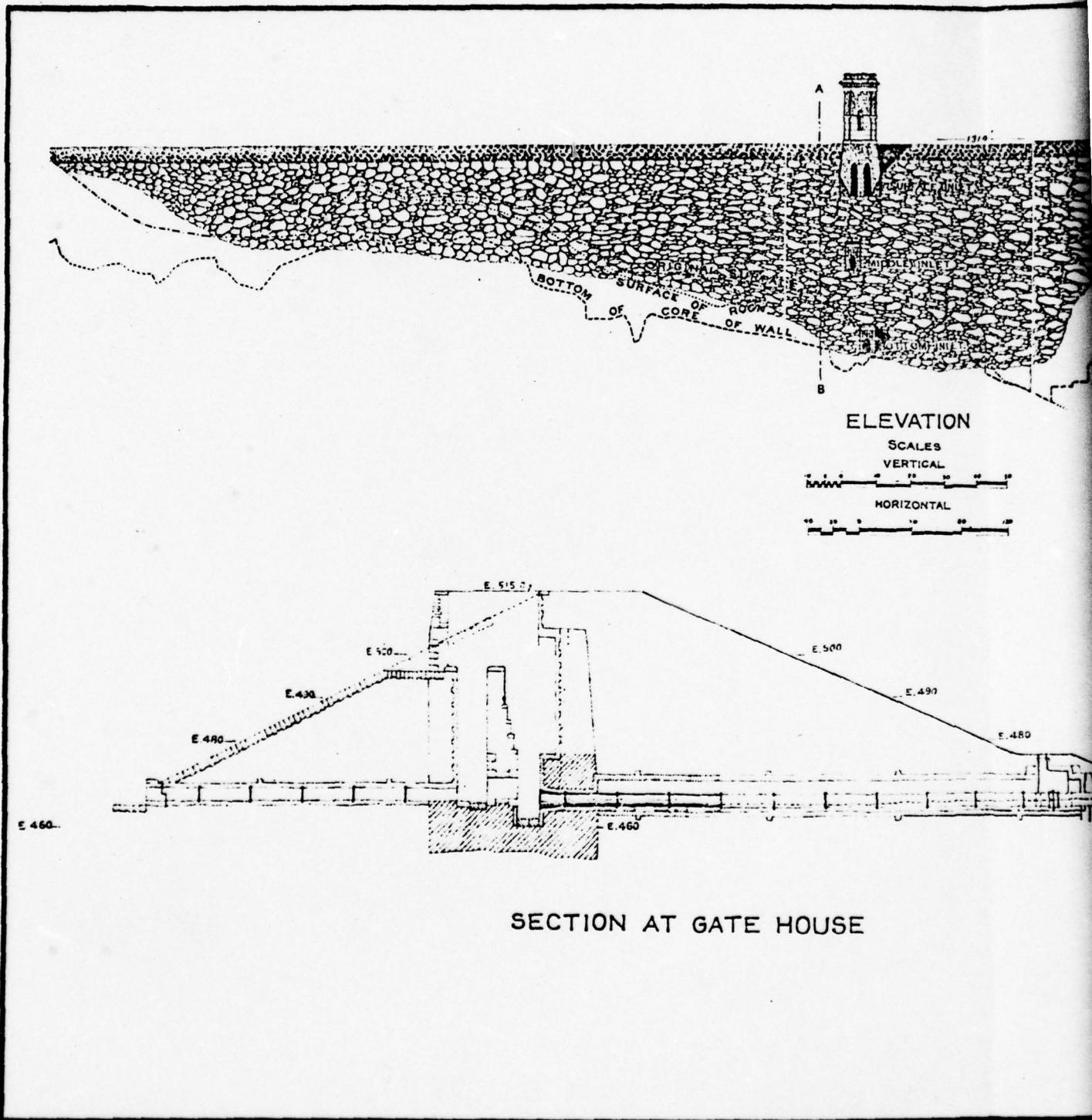


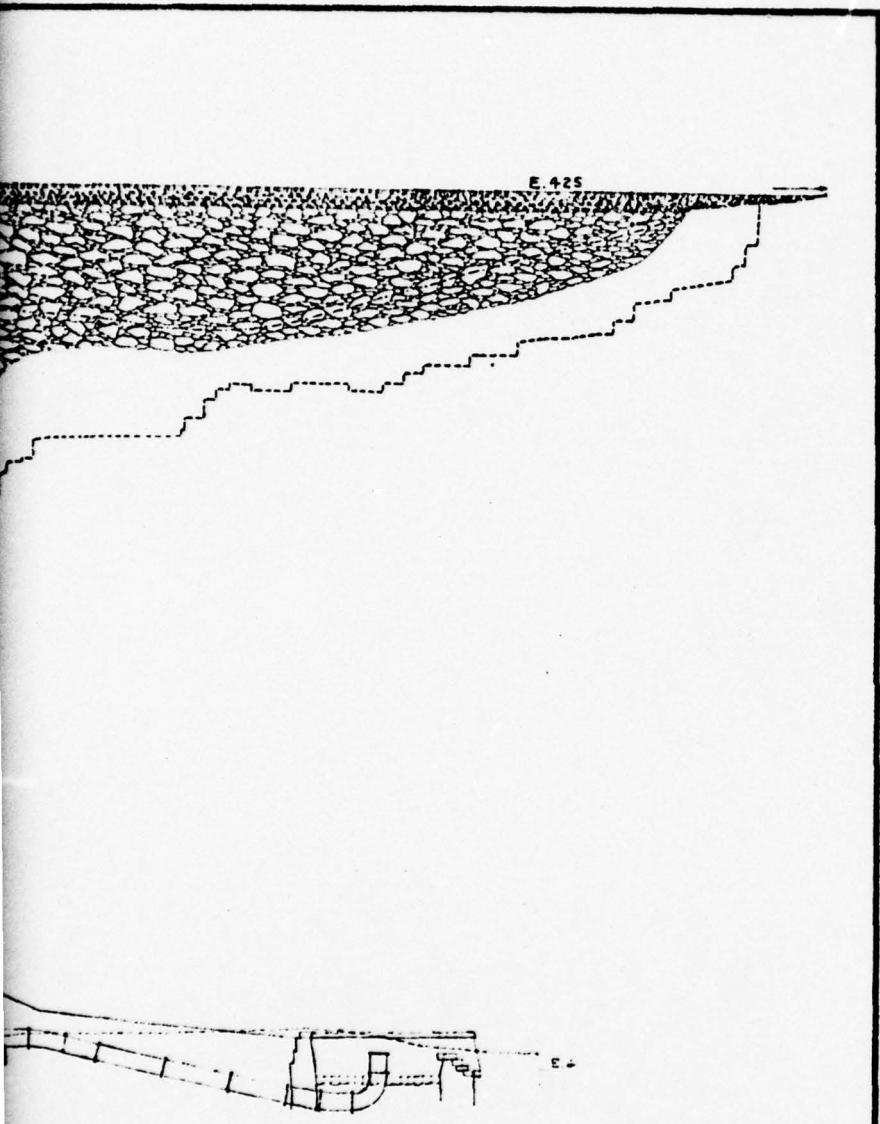
Drawn by A.S.F.
Traced by A.W.F.
Checked by A.W.F. & W.E.K. & G.

FIGURE 7
CITY OF NEW YORK
THE AQUEDUCT COMMISSIONERS

Bog Brook
DOUBLE RESERVOIR "I"
CONNECTING TUNNEL
& GATE HOUSE

MILLION INC.





THE AQUEDUCT COMMISSIONERS
EAST BRANCH RESERVOIR
BOG BROOK DAM N° 1

FIGURE 8

APPENDIX

PHOTOGRAPHS



SATURATED GROUND NEAR RIGHT ABUTMENT
OF DAM NO. 1



CREST OF DAM NO. 2

FIELD INSPECTION REPORT

Check List
Visual Inspection
Phase 1

Name Dam Bog Brook Dam No. 1 County Putnam State New York Coordinators -----
Name Dam Bog Brook Dam No. 2

Date(s) Inspection July 17, 1978 Weather Overcast Temperature 75°

Pool Elevation at Time of Inspection 417 M.S.L. Tailwater at Time of Inspection ----- M.S.L.

Inspection Personnel:

Mr. George Elias

Mr. David Campbell

Mr. Steve Snider

Mr. Steve Snider Recorder

Accompanied by:

Mr. John Birrell - Section Engineer, New York City Department of Environmental Protection
Mr. Edward Stoorza - Section Foreman, New York City Department of Environmental Protection

EMBANKMENT

VISUAL EXAMINATION OF
EMBANKMENT

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

SURFACE CRACKS

None noted.

UNUSUAL MOVEMENT OR
CRACKING AT OR BEYOND
THE TOE

None noted.

SLOUGHING OR EROSION OF
EMBANKMENT AND ABUTMENT
SLOPES

A-2

All growth on Dam No. 2
should be removed.

None noted on Dam No. 1.
Dense vegetation on Dam No. 2:
obstructed visual detection of
this condition.

VERTICAL AND HORIZONTAL
ALIGNMENT OF THE CREST

Two long, shallow depressions
noted in the crest on Dam No. 1.

A study should be made to
determine their cause and if
they are increasing in size.

RIPRAP FAILURES

All growth on Dam No. 2
should be removed.

Some minor loss of cobble backfill
noted at the waterline on Dam No. 1.
Dense vegetation on Dam No. 2:
obstructed visual detection of this
condition.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
------------------------------	---------------------	-----------------------------------

**JUNCTION OF EMBANKMENT
AND ABUTMENT, SPILLWAY
AND DAM**

Seepage noted at the north abutment of Dam No. 1. Ground surface was moist and saturated in some locations.

A study should be undertaken to determine the cause and source of seepage and it should be monitored continuously to detect turbidity or increased flow.

ANY NOTICEABLE SEEPAGE

A-3

See above.

See above.

STAFF GAGE AND RECORDER

N/A

DRAINS

The two drains for both dams are partially filled with vegetation and debris.

The drains should be cleaned to insure proper collection of runoff and seepage.

OUTLET WORKS		REMARKS OR RECOMMENDATIONS
VISUAL EXAMINATION OF	OBSERVATIONS	
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None noted.	None.
INTAKE STRUCTURE	Emergency butterfly valve inoperable at time of inspection.	Repair valve.
OUTLET STRUCTURE	A-4	One of the gate valves was inoperable at time of inspection. Stop logs in downstream slot of middle inlet were not properly seated allowing about 30 gpm to pass into outlet conduit.
OUTLET CHANNEL		Some grass and brush growing from stone walls of stilling pond.
EMERGENCY GATE		See "Outlet Structure"

RESERVOIR

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

VISUAL EXAMINATION OF

SLOPES

No problems noted.

None.

SEDIMENTATION

None noted.

None.

DOWNSTREAM CHANNEL		
VISUAL EXAMINATION OF CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	No problems noted.	None.
SLOPES	Slopes of channel heavily overgrown with brush and some small trees.	None.
APPROXIMATE NO. OF HOMES AND POPULATION	The Village of Brewster, New York, is located within 1½ miles of both dams. The population is approximately 1,600 (800 homes).	None.
	A-6	

<u>ITEM</u>	<u>REMARKS</u>
MONITORING SYSTEMS	Personnel from the New York City Department of Environmental Protection operate and monitor operation of the reservoir.
MODIFICATIONS	None.
HIGH POOL RECORDS	Maximum pool of record was 419.15 feet MSL recorded on October 16, 1955.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None noted.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None noted.
Maintenance OPERATION RECORDS	None available.

ITEM	REMARKS
DESIGN REPORTS	Two reports entitled "Report to the Aqueduct Commissioners, 1887-1895 and 1895-1907" contain brief discussions pertinent to the purpose, operation and construction of the Bog Brook Dams and appurtenances.
GEOLOGY REPORTS	None available.
DESIGN COMPUTATIONS	
HYDROLOGY & HYDRAULICS	None available.
DAM STABILITY	
SEEPAGE STUDIES	
A-8	
MATERIALS INVESTIGATIONS	
BORING RECORDS	None available.
LABORATORY	
FIELD	
POST-CONSTRUCTION SURVEYS OF DAM	None available.
BORROW SOURCES.	Unknown.

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

NAME OF CLIENT NYSDEC

PROJECT Bog Brook Reservoir

Bog Brook Reservoir & East Branch Reservoir are connected by a 10' diameter tunnel, and the spillway @ East Branch provides for outflow from both reservoirs.

Total drainage area = 80.28 square miles

$$L = 19 \text{ miles} \quad L_{CA} = 8 \text{ miles}$$

$$t_p = C_t (L \times L_{CA})^3 = 2.0 (19 \times 8)^3 = 9.0 \text{ hrs}$$

$$t_R = t_p / 5.5 = 1.6 \text{ hrs.} \quad \stackrel{\text{use}}{t_R} = 1.5 \text{ hrs.}$$

Spillway crest at East Branch = 416.55 ft MSL

Spillway length = 500'

Surface area of reservoirs @ normal pool = 956 acres

Surface area @ El. 420 = 1225 acres

Assume area a linear function of elevation above the crest.

$$A = 78H + 956 \quad \& \frac{\text{Surcharge}}{\text{Storage}}(S) = \int (78H + 956)$$

$$S = 39H^2 + 956H + 956$$

NAME OF CLIENT

NYSDEC

PROJECT

Bog Brook Reservoir

Stage - Storage Relation

Elevation	H (ft)	S (acre-ft)
416.55	0	0
418.0	1.45	1468
420.0	3.45	3762
421.0	4.45	5026
422.0	5.45	6369
423.0	6.45	7789
424.0	7.45	9287
425.0	8.45	10863
426.0	9.45	12516
427.0	10.45	14249

Stage - discharge relation

$$\text{Spillway} - Q_s = 3.5 \times 500 \times H^{3/2}$$

$$\text{Top of dam @ El 425} \quad Q_{ot} = 3.1 \times 3300 \times (H - 8.45)^{3/2}$$

Elevation	H	<u>Q_s</u>	<u>Q_{ot}</u>	<u>Q_T</u>
416.55	0	0	0	0
418.00	1.45	3056	0	3056
420.00	3.45	11214	0	11214
421.00	4.45	16428	0	16428
422.00	5.45	22266	0	22266
423.00	6.45	28667	0	28667
424.00	7.45	35585	0	35585
425.00	8.45	42986	0	42986
426.00	9.45	50837	10230	61067
427.00	10.45	59117	28935	88052

JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

NAME OF CLIENT

NYSDEC

PROJECT

Bog Brook Reservoir

SHEET NO. 3 OF 6

DATE 8/2/78

COMP. BY DBC

CHECKED BY REH

$$6\text{HR. PMP} = 24"$$

Reduction for "probable mistfit" of storm
isohyets and drainage basin = 14%

$$6\text{HR PMP}_{\text{REDUCED}} = 20.64"$$

$$\text{ZONE 1, 80 SQ. MILES } 6\text{HR PMP} = 20.64 \times .77 = 15.9$$

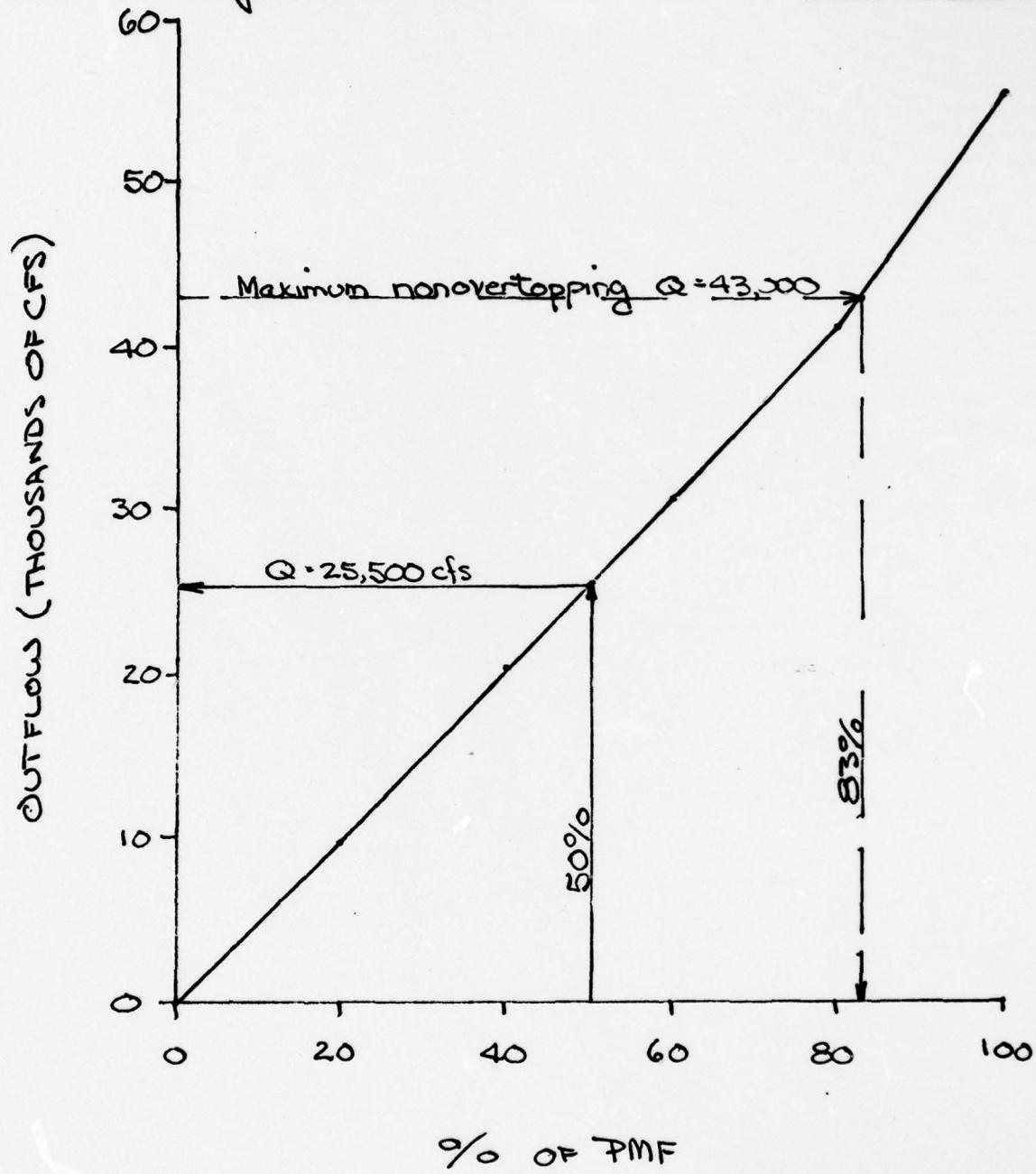
Time	Σ	PMP	
0	0	0	.5
1.5	9.0	9.0	.6
3.0	12.1	3.1	1.8
4.5	14.1	2.0	2.0
6.0	15.9	1.8	3.1
7.5	12 HR PMP = $20.64 \times .89$ = 18.4	.7	9.0
9.0		.7	.7
10.5	12 HR - 6 HR = 2.5"	.6	.7
12.0		.5	

JUSTIN & COURTNEY, INC.
 Division of O'Brien & Gere Engineers, Inc.
 PHILADELPHIA, PA

SHEET NO. 4 OF 6
 DATE 9/7/78
 COMP. BY DBC
 CHECKED BY RELL

NAME OF CLIENT NYSDEC

PROJECT Bog Brook



JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

NAME OF CLIENT NYSDEC

PROJECT Bog Brook Dam

SHEET NO. 5 OF 6
DATE 8/15/78
COMP. BY DBC
CHECKED BY REH

Drawdown Computations

Outlet Discharge (tunnel assumed closed)

$$H = \left(1 + K_e + K_v + K_s + \frac{29 n^2 L}{r^{4/3}} \right) \frac{V^2}{2g}$$

K_e = entrance and exit losses

K_v = valve loss

K_s = sleeve loss

$$n = .025 \quad L = 450' \quad \frac{V^2}{2g} = \frac{Q^2}{2gA^2}$$

$$H = \left(1 + 1.5 + .5 + .25 + \frac{29 (0.025)^2 450}{.75^{4/3}} \right) \frac{Q^2}{2g(\pi 1.5^2)^2}$$

$$H = \frac{(2.5c)}{3217.7} Q^2 = .00235 Q^2$$

$$\therefore Q = 20.63 H^{.5} \text{ (per pipe)} \quad Q_T = 41.26 H^{.5}$$

Assume an inflow of 2 c.f.s./sq. mi. $\times 3.67 \text{ sq.mi.} = 7.3 \text{ cfs}$

$$\therefore Q_{NET} = 41.26 H^{.5} - 7.5 \quad \begin{matrix} \text{Assume } TW = 356.6 \\ (\text{Lip of stilling basin weir } 354.6) \end{matrix}$$

H	55	45	35	25	15
Q	298	269	237	199	152

NAME OF CLIENT NYSDDEC

DATE 8/15/78

PROJECT Bog Brook

COMP. BY DGC

CHECKED BY REH

Normal pool volume = 13500 acre-feet
Depth normal pool to lower outlet invert = 50'
Surface area = 399.0 acres

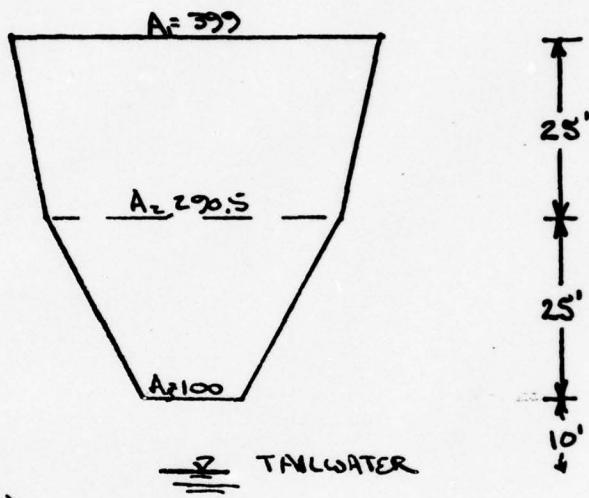
Assume Area at lower outlet invert = 100 acres

$$V = 13500 \text{ acre-ft}$$

$$= \frac{399 + A_2}{2} \times 25 +$$

$$\frac{A_2 + 100}{2} \times 25$$

$$A_2 = 290.5 \text{ acres}$$



ΔH	H _{Ave}	A _{Ave}	ΔS	Q _{NETAKE}	$\Delta T(HRS)$	$\Sigma T(DAYS)$
60 → 50	55	377	3770	298	153	6.4
50 → 40	45	334	3340	269	150	12.6
40 → 30	35	291	2910	237	149	18.8
30 → 20	25	252	2520	199	153	25.2
20 → 10	15	138	1380	152	110	29.8

→ DRAWDOWN TIME

≈ 30 days

DEC-1 VERSION DATED JAN 1973
UPDATED AUG 74
CHANGE-NQ-.01

NATIONAL DAM INSPECTION PROGRAM
DOG BROOK RESERVOIR
PMF HYDROGRAPH

JOB SPECIFICATION					
NO	NHR	NMIN	IDAY	IHR	IMIN
50	1	30	1	0	0
IPLT IPRT NSTAN					
JOPER NHJ					
5	0				

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTD= 5 LRTD= 1
R10S=.20 .40 .60 .80 1.00

A-15

SUB-AREA RUNOFF COMPUTATION
ISTAQ ICOMP IECON ITAPE JPLT JPRT INAME

1 0 0 0 0 0 0

HYDROGRAPH DATA
IHUG TAREA SNAP TRSOA TRSPC RATIO ISNOW ISAME LOCAL

0 1 60.28 0.00 0.00 0.00 0.000 0 0 0

PRECIP DATA
NP STORM DAJ DAK

8 0.00 0.00 0.00

PRECIP PATTERN

.50 .60 1.00 2.00 3.10 9.00 .70 .70

LOSS DATA
STKRR DLISR RTOL ERAIN STRIK STRIL CNSTL ALSMX RTIMP
0.00 0.00 1.00 0.00 0.00 1.00 0.00 .10 0.00 0.00

UNIT HYDROGRAPH DATA

TP= 9.00 CR= .63 NTA= 0

RECEDION DATA
STRT= 0.00 QPCSN= 0.00 RTI0R= 1.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 6.86 AND R= 5.37 INTERVALS

UNIT HYDROGRAPH 33 END-OF-PERIOD ORDINATES. LAG= 8.97 HOURS. CP= .63 VOL= 1.00					
232.	847.	1615.	2557.	3272.	3650.
1817.	1507.	1250.	1037.	861.	592.
261.	233.	193.	160.	133.	110.
43.	36.	30.			

END-OF-PERIOD FLOW
TIME RAIN EXCS COMP Q
1 1 30 .50 .35 81.
1 2 60 .60 .45 601.
1 4 30 1.00 1.65 1350.
1 6 30 1.00 1.00 1.00

A-16

		HYPHENOGRAPH AT	STA	1 FOR PLAN 1.	RTIO 2	
32.	160.	540.	1390.	2924.	5846.	15109.
2321.	22010.	13294.	16135.	13426.	11139.	9240.
4376.	3631.	3012.	2499.	2073.	1720.	1426.
676.	564.	465.	382.	313.	243.	183.
0.	0.	0.	0.	0.	0.	0.
						22377.
						5275.
						6359.
						7665.
						1181.
						982.
						614.
						14.
						7.
						0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL
INCHES	2.1212.	2.1774.	1.3197.	.4927.	.236502.
AC-FI	2.052	6.12	6.12	6.12	6.85
	10002	26182	26182	29334	29334

	HYDROGRAPH AT STA 1 FOR PLAN 1. RT103		
49.	240.	610.	4386.
34619.	33014.	24068.	2085.
696.	5446.	4510.	24203.
1013.	941.	637.	20139.
0.	0.	0.	16704.
			13860.
			11498.
			9538.
			7913.
			22663.
			29242.
			33566.

	2FS	34019.	32660.	19795.	7391.	16000.	10000.	354723.
INC-1ES			3.78	9.18			10.28	10.28
AC-FIT		16204.		39284.		44000.		44000.

	PEAK	6-HOUR	24-HOUR	12-HOUR	TOTAL VOLUME
2FS	46425.	43547.	26394.	9854.	47304.
INC-1ES		5.05	12.23	1.370	13.70
AC-FI		21605.	52378.	58667.	58667.

HYDROGRAPH AT STA 1 FOR PLAN 1.					
	R10.5	R10.6	R10.7	R10.8	R10.9
81.	401.	1350.	3475.	7310.	14615.
52031.	5024.	40113.	40336.	33565.	27845.
110941.	9076.	7530.	6246.	5182.	4299.
1689.	1401.	1162.	956.	782.	608.
0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
LES	58031.	54434.	32992.	12318.	291255.
INC-1ES		6.31	15.29	17.13	17.13
AC-FI	27006.	65473.	73334.	73334.	

THE JOURNAL OF CLIMATE

NSIPS	NSTOL	LAG	AMSKK	X	TSK	STORA
0.0	0.000	0.00	0.000	0.000	0.000	-1.
0	0	0	0			

STORAGE = 0. 1629. 3762. 5026. 6369. 7749. 9287. 10663. 12516. 14249.
OUTFLOW = 0. 3056. 11214. 16428. 22266. 28667. 35585. 42986. 50052. 61067.

A-17

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
2FS	9752.	9330.	6164.	2463.	118272.
INC-FS		1.08	2.86	3.43	3.43
AC-FI	4629.	12233.	14666.	14669.	
		STATION	2, PLAN 1, RT10 2		
10000.	32.	116.	732.	1567.	3048.
7050.	19957.	310.	19159.	17300.	15221.
1552.	5949.	20242.	17300.	15221.	13172.
1552.	1358.	5000.	4189.	3501.	2971.
1552.	1150.	984.	836.	710.	597.
1552.	102.				
1552.	102.				

A-18

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	30710.	29480.	19041.	7391.	354630.
INCHES		3:42	8:83	10:28	
AC-FIT	14626.	37787.	44000.	44010.	
STATION	2.	PLAN 1.	RIV 0	4.	
65.	96.	233.	621.	1465.	22999.
37653.	41082.	41160.	38554.	34513.	31291.
13214.	11107.	9494.	8025.	25919.	15662.
2563.	2260.	1978.	1719.	1485.	2881.
453.	338.	261.	201.	120.	566.
				92.	55.
				71.	42.

4247.	3732.	3270.	2874.	2520.	2215.	1954.	1733.	1547.	1384.
1231.	1096.	950.	826.	713.	611.	518.	436.	350.	272.
211.	162.	125.	97.	75.	58.	44.	34.	26.	20.

2FS	41160.	39620.	25462.	9854.	72-HOUR	TOTAL VOLUME	473113.
INC-ES	4.59	11.81	13.70	13.71			
AC-FT	19656.	50570.	5A663.	5A681.			

	STATION	2.	PLAN 1.	RATIO	5
81.	118.	291.	776.	1031.	4419.
51040.	55475.	52318.	45779.	36119.	31373.
16219.	13690.	11496.	9800.	8326.	5911.
2945.	2625.	2318.	2030.	1765.	1520.
529.	408.	315.	243.	187.	144.

	STOR				
39.	56.	140.	373.	880.	1051.
11599.	12005.	11716.	11118.	10347.	9401.
4975.	4362.	3830.	3364.	2949.	2585.
1415.	1261.	1114.	975.	848.	730.
254.	196.	151.	117.	90.	69.

2FS	55475.	51153.	31931.	12318.	TOTAL VOLUME	591397.
INC-ES	5.	9.3	14.80	17.13		17.13
AC-FT	25378.	63367.	73337.	73352.		328.

PEAK FLOW SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

OPERATION STATION PLAN .20 .40 .60 .80 .100 RATIO'S APPLIED TO FLOWS

HYDROGRAPH AT	1	1	11606.	23212.	34019.	46425.	58031.
ROUTED TO	2	2	0.	0.	0.	0.	0.
	1	1	9757.	20262.	30710.	41160.	55475.
	2	2	0.	0.	0.	0.	0.

PREVIOUS INSPECTION REPORT

After examining each one of these forms, is completely answered for each dam in your district, return it at once to the
Conservation Commission, Albany.

STATE OF NEW YORK
CONSERVATION COMMISSION
ALBANY

DAM REPORT

August 5th, 1915

CONSERVATION COMMISSION,

DIVISION OF INLAND WATERS.

GENTLEMEN:

I have the honor to make the following report in relation to the structure known as

Bog Brook

Dam.

This dam is situated upon the.....

(Give name of stream)

in the Town of South East, Putnam County,

about 1 1/2 miles from the Village Ward of Brewster.

The distance ~~of water~~ stream from the dam, to the ~~of water~~ End of Lake,

is about 1 mile.

The dam is now owned by New York City.

and was built in or about the year 1891, and was extensively repaired or reconstructed during the year.....

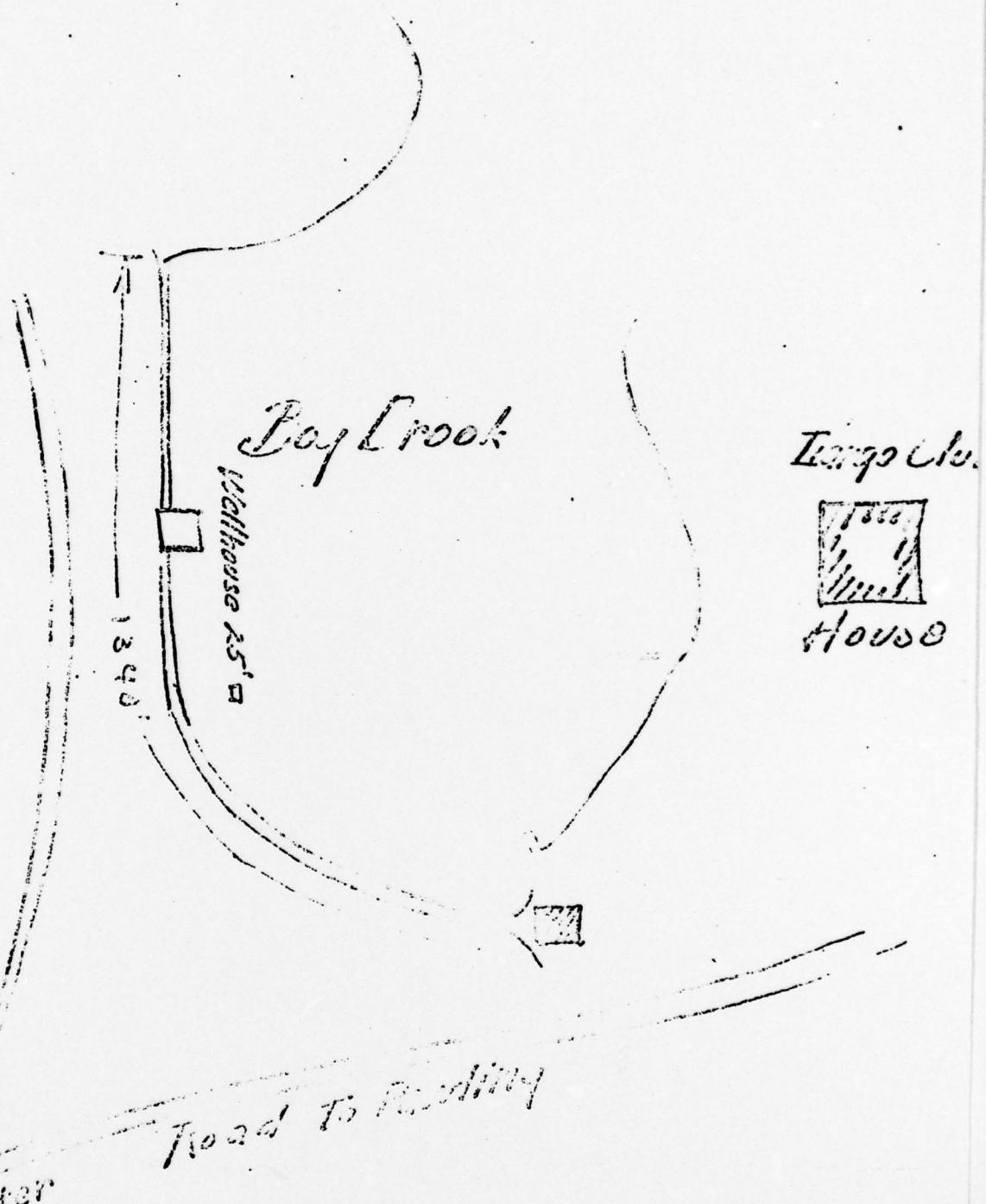
As it now stands, the spillway portion of this dam is built of concrete and the other portions are built of concrete.

As nearly as I can learn, the character of the foundation bed under the spillway portion of the dam is sand, gravel, and stones and under the remaining portions such foundation bed is sand, gravel, and stones.

A20

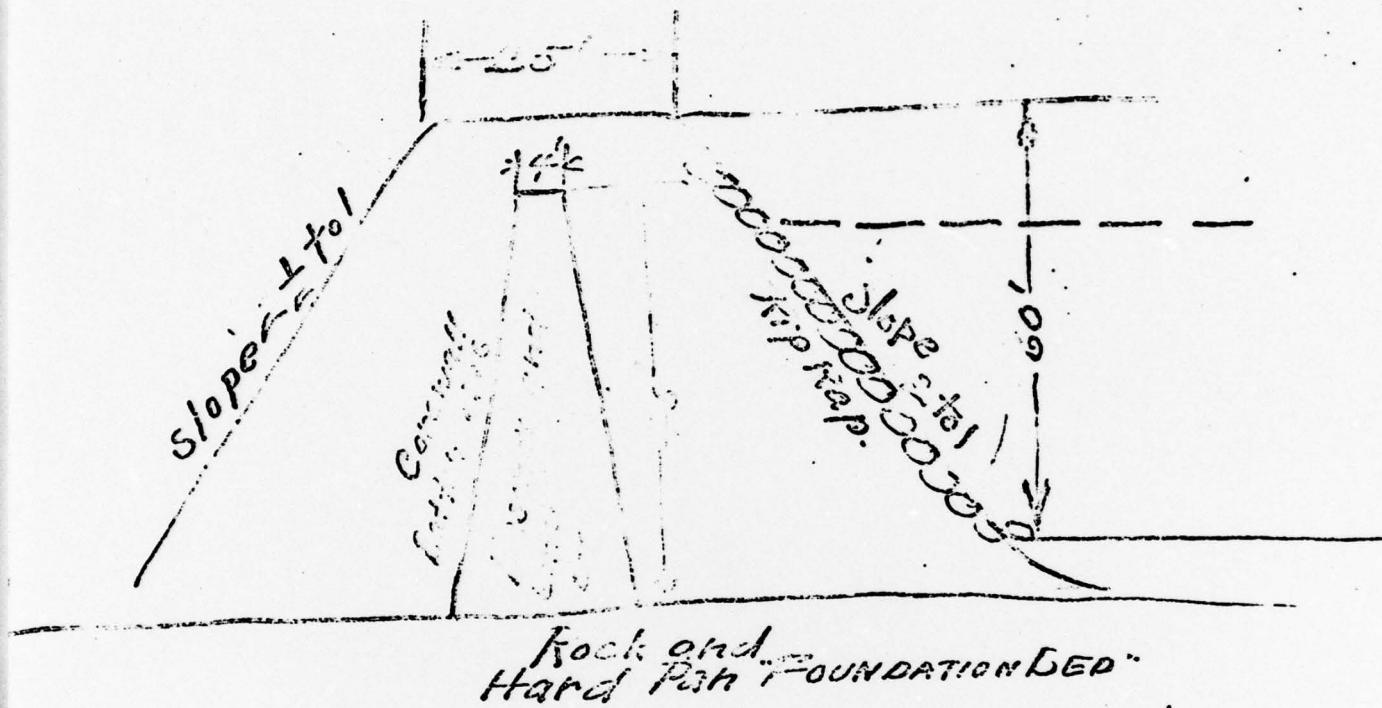
Map 231- 525 LH

(In the space below, make a third sketch showing the general plan of the dam, and its approximate position in relation to buildings and other conspicuous objects in the vicinity.)



In the space below, make one sketch showing the form and dimensions of a cross section through the spillway or waste-weir of this dam, and a second sketch showing the same information for a cross section through the other portion of the dam. Show particularly the greatest height of the dam above the stream bed, its thickness at the top, and thickness at the bottom, as nearly as you can learn.)

ONLY ONE SECTION NO SPILL WAY



A22

The total length of this dam is.....102.62.....ft. The spillway or waste-water portion, is about 100 ft. feet long, and the crest of the spillway is about.....10.....feet below the top of the dam.

The number, size and location of discharge pipes, waste pipes or gates which may be used for drawing off the water from behind the dam, are as follows:.....Two 30" pipes near well house as shown.....

At the time of this inspection the water level above the dam was 2.5 ft. _____in. below the crest of the spillway.

(State briefly, in the space below, whether, in your judgment, this dam is in good condition, or bad condition, describing particularly any leaks or cracks which you may have observed.)

This dam occurs to be in good condition and with a small possibility of giving way. If the dam did break this would be caused quite a large loss to property losses on account of blockade being put up at the lower damming.

Reported by L. H. Johnson

Address: State of California, P. O. Box R. E. D. 100

State of California

STATE OF NEW YORK

DEPARTMENT OF

State Engineer and Surveyor

ALBANY

Report of a Structure Impounding Water

To assist in carrying out the provisions of Section 22 of the Conservation Law, being Chapter LXV of the Consolidated Laws of New York State, relating to safeguarding life and property and the erection, reconstruction, or maintenance of structures for impounding water, owners of such structures are requested to fill out as completely as possible this report form for each such dam or reservoir owned within the State of New York for which no plans or reports relative thereto are on file in this Department, and to return this report form, together with prints or photographs explanatory thereof to this department.

Boe Brook Dam, No. 1

Croton Ri

1. The structure is on Boe Brook flowing into East Branch of in the Town of Southeast County of Putnam and New York

about a quarter of a mile S.E. from the Cross Roads in Sodom, Putnam Co., New York.
(Give exact distance and direction from a well-known bridge, dam, village main cross-roads or mouth of a stream)

2. Is any part of the structure built upon or does its pond flood any State lands? no

3. The name and address of the owner is the City of New York

4. The structure is used for impounding water for water supply

5. The material of the right bank, in the direction with the current, is; at the spillway crest elevation this material has a top slope of inches vertical to a foot horizontal on the center line of the structure, a vertical thickness at this elevation of feet, and the top surface extends for a vertical height of feet above the spillway crest.

6. The material of the left bank is; has a top slope of inches to a foot horizontal, a thickness of feet and a height of feet.

7. The natural material of the bed on which the structure rests is (clay, sand, gravel, boulders, granite, shale, slate, limestone, etc.) sand, gravel and hardpan.

8. State the character of the bed and the banks in respect to the hardness, perviousness, water bearing, effect of exposure to air and to water, uniformity, etc.

9. If the bed is in layers, are the layers horizontal or inclined? If inclined what is the direction of the horizontal outcropping relative to the axis of the main structure and the inclination and direction of the layers in a plane perpendicular to the horizontal outcropping?

10. What is the thickness of the layers?

11. Are there any porous seams or fissures?.....

12. The watershed at the above structure and draining into the pond formed thereby is 3.67 square miles.

13. The pond area at the spillway crest elevation is.....39.9.....acres and the pond impounds.....586,511 cubic feet of water.

14. The maximum known flow of the stream at the structure was cubic feet per second on

(Date)

15. Has the spillway capacity ever been exceeded by a high flow? no

Can any possible flood flow from the pond otherwise than through the wastes noted under 17 and 18 of this report?.....**no**..... If so, give the location, the length and the elevation relative to the spillway crest and the character and slopes of the ground of such possible wastes.....

16. State if any damage to life or to any buildings, roads or other property could be caused by any possible failure of the above structure. Describe the location, the character and the use of buildings below the structure which might be damaged by any failure of the structure; of roads adjacent to or crossing the stream below the structure, giving the lowest elevation of the roadway above the stream bed and giving the shape, the height and the width of stream openings; and of any embankments or steep slopes that any flood could pass over. Also indicate the character and use made of the ground below the structure.

No great damages or loss of life would be caused by the failure of the dam.

17. WASTES. The spillway of the above structure is.....feet long in the clear; the waters are held at the right end by a.....the top of which is.....feet above the spillway crest, and has a top width of.....feet; and at the left end by a....., the top of which is.....feet above the spillway crest, and has a top width of.....feet.

18. There is also for flood discharge a pipe 36 inches inside diameter and the bottom is ~~at~~ 10 feet below the ~~top of the dam~~ and a (sluice, gate outlet)..... feet wide in the clear by..... feet high, and the bottom is..... feet below the spillway crest.

19. APROX. Below the spillway there is ~~exception~~^(Material) of a concrete apron.....
.....12-15 inches thick. The downstream side of the apron has a thickness of..... feet
for a width of.....feet.

20. Has the structure any weaknesses which are liable to cause its failure in high flows?

NO.....

21. SKETCHES. On the back of this report make a sketch to scale for each different cross-section of the above structure at the greatest depth; giving the height and the depth from the surface of the foundation, the bottom width, the top width (for a concrete or masonry spillway at two feet below the crest), the elevation of the top in reference to the spillway crest, the length of the section, and the material of which the section is constructed; on the spillway section show a cross section of the apron, giving its width, thickness and material, and show the abutment or wash wall at the end of the spillway, giving its heights and thickness. Mark each section with a capital letter. Also sketch a plan; show the above sections by their top lines, giving the mark and the length of each; the openings by their horizontal dimensions; the abutments by their top width and top lengths from the upstream face of the spillway section; and outline the apron. Also sketch an elevation of each end of the structure with a cross section of the banks, giving the depth and width excavated into the banks.

22. WATER SUPPLY. The waters impounded by the above structure have (not) been used for a public water supply since.....1891.....by.....the City of New York.....

Spillway. There is no spillway for this dam as the Bog Brook Reservoir is connected by a tunnel with the Sodom Reservoir, which has a spillway, 500 feet wide.

NOTE: If, at any time, any one of these forms, or completely as possible for one, than in your district, return it at once to the
Conservation Commission, Albany.

STATE OF NEW YORK
CONSERVATION COMMISSION
ALBANY

DAM REPORT

August 5th, 1915
Day

CONSERVATION COMMISSION,

DIVISION OF INLAND WATERS.

GENTLEMEN:

I have the honor to make the following report in relation to the structure known as
the Bog Brook Auxiliary Dam.

This dam is situated upon the Bog Brook Reservoir
in the Town of South East, Putnam County,
about 1 $\frac{3}{4}$ miles from the Village Ward Brewster.

The distance..... stream from the dam, to the.....
is about.....
(Give name of nearest important stream or a tributary)

The dam is now owned by New York City
(Give name, address, etc.)
and was built in or about the year 1890, and was extensively repaired or reconstructed
during the year —.

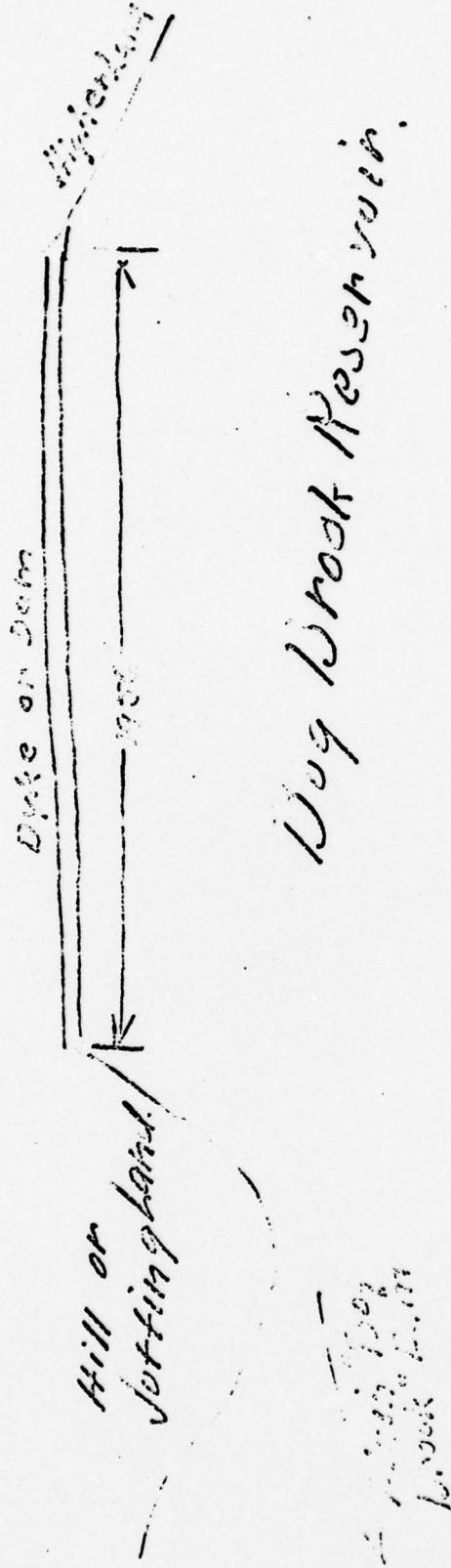
As it now stands, the spillway portion of this dam is built of concrete
and the other portions are built of concrete.

As nearly as I can learn, the character of the foundation bed under the spillway portion
of the dam is and under the remaining portions such
foundation bed is

Aug. 23! C_{A27}

(In the space below, make a third sketch showing the general plan of the dam, and its approximate position in relation to buildings, or other conspicuous objects in the vicinity.)

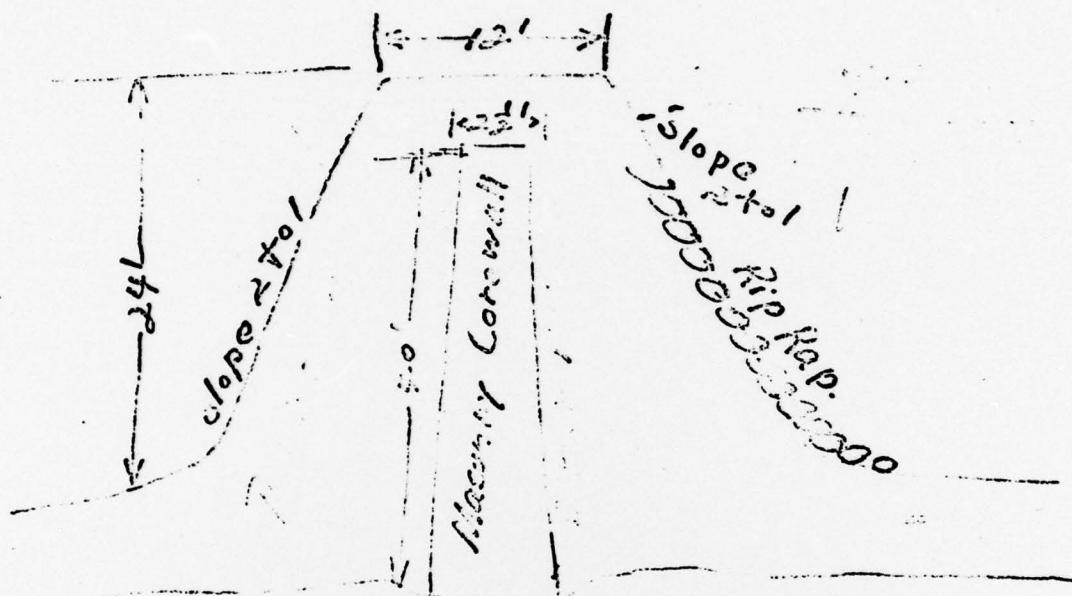
← Road South to BREWSTER.



This sketch shows the location of the reservoir.
The dam is located on the hill or rolling land.
The ditch is located near the reservoir.
The reservoir is located near the dog brook.

In the space below, make one sketch showing the form and dimensions of a cross section through the spillway or waste-way of this dam, and a second sketch showing the same information for a cross section through the other portion of the dam. Show particularly the great variation of the dam above the stream bed, its thickness at the top, and difference at the bottom, as nearly as you can learn.)

No spillway. Only one c.c.



Rock and Head Dam West.

The dam is 150 feet long. The spillway or waste water outlet is 150 feet long, and the crest of the spillway is 10 feet below the top of the dam.

The number, size and location of discharge pipes, waste pipes or gates which may be used for drawing off the water from behind the dam, are as follows:

Passage outlets

At the time of this inspection the water level above the dam was 5.5 ft. 10 in. below the crest of the spillway.

(State briefly, in the space below, whether, in your judgment, this dam is in good condition, or bad condition, describing particularly any cracks or cracks which you may have observed.)

This dam seemed to be in good condition with no likelihood of failing because it is made of a stone which is hard for water to penetrate and the stones are well bedded.

Reported by

STATE OF NEW YORK

DEPARTMENT OF

State Engineer and Surveyor

ALBANY

Report of a Structure Impounding Water

To assist in carrying out the provisions of Section 22 of the Conservation Law, being Chapter LXV of the Consolidated Laws of New York State, relating to safeguarding life and property and the erection, reconstruction, or maintenance of structures for impounding water, owners of such structures are requested to fill out as completely as possible this report form for each such dam or reservoir owned within the State of New York for which no plans or reports relative thereto are on file in this Department, and to return this report form, together with prints or photographs explanatory thereof to this department.

Rog Brook Dam No. 2 at the

1. The structure is ~~an~~ ^{an} depression forming Rog Brook Reservoir in the
Town of Southeast County of Putnam State of New York
about 1-1/10 miles north of Rog Brook Dam No. 1 center to center
(Give exact distance and direction from a well-known bridge, dam, village main street or mouth of a stream)

2. Is any part of the structure built upon or does its pond flood any State lands? **no**
3. The name and address of the owner is **City of New York**

4. The structure is used for impounding water for water supply

5. The material of the right bank, in the direction with the current, is ; at the
spillway crest elevation this material has a top slope of inches vertical to a foot horizontal on the
center line of the structure, a vertical thickness at this elevation of feet, and the top surface extends
for a vertical height of feet above the spillway crest.

6. The material of the left bank is ; has a top slope of inches
to a foot horizontal, a thickness of feet and a height of feet.

7. The natural material of the bed on which the structure rests is (clay, sand, gravel, boulders, granite, shale,
slate, limestone, etc.) **Clay** sandy loam, hardpan
.....

8. State the character of the bed and the banks in respect to the hardness, perviousness, water bearing, effect
of exposure to air and to water, uniformity, etc.

9. If the bed is in layers, are the layers horizontal or inclined? If inclined what is the direction of the horizontal outcropping relative to the axis of the main structure and the inclination and direction of the layers in a plane perpendicular to the horizontal outcropping?

10. What is the thickness of the layers?.....

11. Are there any porous seams or fissures?.....

12. The watershed at the above structure and draining into the pond formed thereby is 3.67 square miles.

13. The pond area at the spillway crest elevation is .229 acres and the pond impounds 52.8 cu. ft.

14. The maximum known flow of the stream at the structure was..... cubic feet per second on

(Date)

15. Has the spillway capacity ever been exceeded by a high flow? No.

Can any possible flood flow from the pond otherwise than through the wastes noted under 17 and 18 of this report? No. If so, give the location, the length and the elevation relative to the spillway crest and the character and slopes of the ground of such possible wastes.....

16. State if any damage to life or to any buildings, roads or other property could be caused by any possible failure of the above structure. Describe the location, the character and the use of buildings below the structure which might be damaged by any failure of the structure; of roads adjacent to or crossing the stream below the structure, giving the lowest elevation of the roadway above the stream bed and giving the shape, the height and the width of stream openings; and of any embankments or steep slopes that any flood could pass over. Also indicate the character and use made of the ground below the structure.

16. No great damages would be caused if the dam should fail.

17. WASTES. The spillway of the above structure is.....feet long in the clear; the waters are held at the right end by a.....the top of which is.....feet above the spillway crest, and has a top width of.....feet; and at the left end by a....., the top of which is.....feet above the spillway crest, and has a top width of.....feet.

18. There is ~~a~~ ^{no} flood discharge a pipe.....inches inside diameter and the bottom is.....feet below the spillway crest; and a (sluice, gate outlet).....feet wide in the clear by.....feet high, and the bottom is.....feet below the spillway crest.

19. APRON. Below the spillway there is ~~an~~^{No} apron ~~BRICK~~^{MATERIAL}.....
feet wide and..... feet thick. The downstream side of the apron has a thickness of..... feet
for a width of..... feet.

20. Has the structure any weaknesses which are liable to cause its failure in high flows? *No*

21. SKETCHES. On the back of this report make a sketch to scale for each different cross-section of the above structure at the greatest depth; giving the height and the depth from the surface of the foundation, the bottom width, the top width (for a concrete or masonry spillway at two feet below the crest), the elevation of the top in reference to the spillway crest, the length of the section, and the material of which the section is constructed; on the spillway section show a cross section of the apron, giving its width, thickness and material, and show the abutment or wash wall at the end of the spillway, giving its heights and thickness. Mark each section with a capital letter. Also sketch a plan; show the above sections by their top lines, giving the mark and the length of each; the openings by their horizontal dimensions; the abutments by their top width and top lengths from the upstream face of the spillway section; and outline the apron. Also sketch an elevation of each end of the structure with a cross section of the banks, giving the depth and width excavated into the banks.

22. WATER SUPPLY. The waters impounded by the above structure have (not) been used for a public water supply since 1891..... by the City of New York

Spillway. There is no spillway for this dam as the Bog Brook Reservoir is connected by a tunnel with the Sodom Reservoir which is provided with a spillway, 500 feet wide.